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A COMPARATIVE STUDY OF VIDEO TAPE RECORDINGS.

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THE COMPARATIVE EFFECTIVENESS OF PRESENTLY AVAILABLE VIDEO TAPE MACHINES IS REPORTED, FOR THE CONVENIENCE OF SCHOOL ADMINISTRATORS PLANNING TO USE SUCH EQUIPMENT IN EDUCATIONAL PROGRAMS. TESTS WERE CONDUCTED AT THE WIENS ELECTRONIC LABORATORIES. MACHINE BRANDS TESTED WERE AMPEX, CONCORD, MACHTRONICS, PRECISION, RCA, SONY, AND WOLLENSAK. A DETAILED MECHANICAL COMPARISON IS GIVEN IN CHARTS AND GRAPHS. AVAILABILITY OF INSTRUCTIONAL TELEVISION MATERIAL IS SHOWN ON A TABLE OF PRODUCTION CENTERS AND DISTRIBUTING LIBRARIES. (MS)

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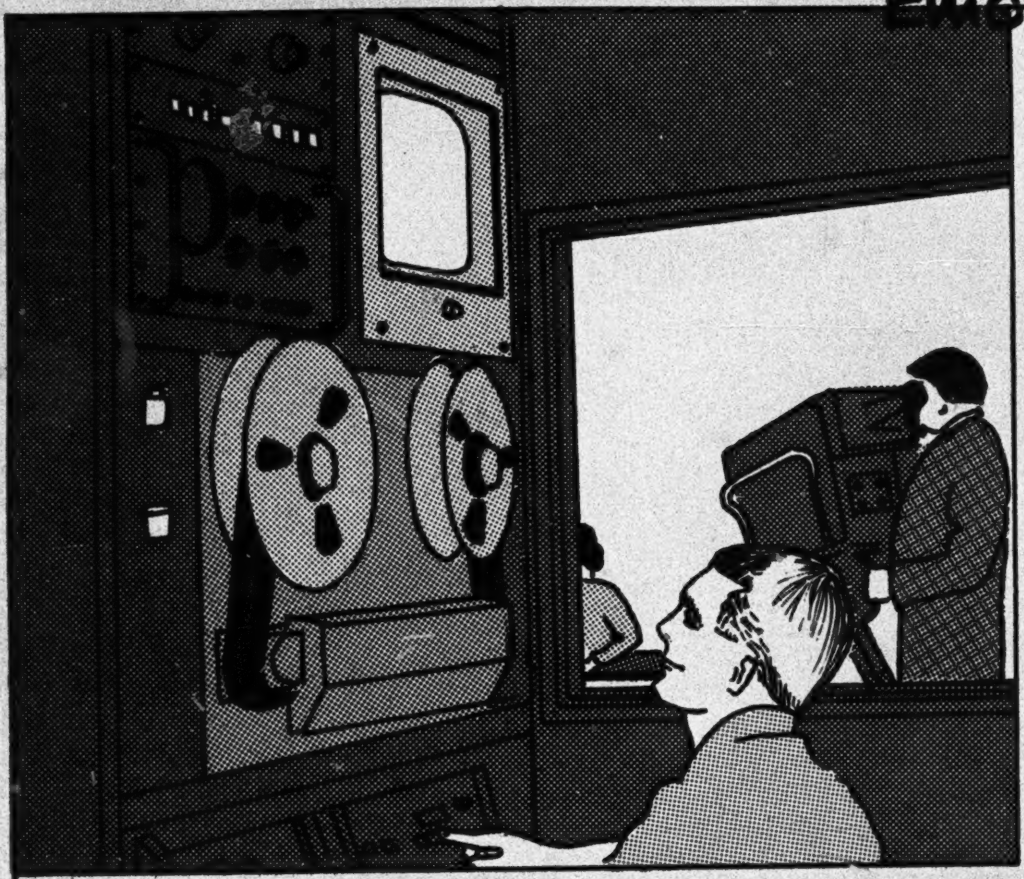

A COMPARATIVE STUDY

VIDEO TAPE RECORDERS

CALIFORNIA STATE DEPARTMENT OF GENERAL SERVICES

SACRAMENTO - JUNE 1967

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

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A COMPARATIVE STUDY OF VIDEO TAPE RECORDERS

by

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Prepared under
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by
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Woodside, California

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FOREWORD

In keeping with the policy of making information available concerning various aspects of educational television in California, the Department of General Services has published this report for appropriate distribution throughout the State. The tremendous interest in the qualifications of the various video recorders now available indicates the need to make the kind of information this report contains readily accessible.

The comparisons and tests presented in this publication were developed and carried into effect at the Wiens Electronic Laboratories by a team of electronics specialists headed by Dr. Jacob H. Wiens under contract with the Bureau of Audio-Visual and School Library Education of the State Department of Education. The conclusions do not necessarily reflect the official recommendations of any State agency.

General Andrew Lolli
Director
Department of General Services

PREFACE

The many different kinds of video tape machines currently being manufactured by various companies throughout the world pose a serious dilemma for school administrators in selecting program equipment whether they are planning to record or play back television programs. This report of the effectiveness of presently available video tape machines has been prepared to assist school personnel to make more realistic appraisals of the capabilities of the machines before making a selection.

The results of the tests described in this study are not considered to be comprehensive or all-inclusive. All the recorders were voluntarily submitted for testing by the manufacturers. It is possible that some of the machines submitted were demonstration models rather than off-the-line models; they were tested just as received. Therefore, in studying the report, it should be kept in mind that different machines of the same kind might have exhibited other characteristics under identical tests.

The tests on the machines were conducted at the Wiens Electronic Laboratories at the request of the State Department of Education, Bureau of Audio-Visual and School Library Education in consultation with the Public School Instructional Television Committee and the office of the State Coordinator of Educational Television. Special acknowledgements should be made for the work of the team of electronics specialists which conducted the tests. The team was composed of Dr. Jacob H. Wiens, Director of the College of the Air; Thomas J. Brames, Electronics Department; Francis J. Morgan, Chief Engineer, KCSM-TV; and Walter J. Nichol, Technician, KCSM-TV; all from San Mateo College, San Mateo, California.

Harry J. Skelly, Chief	Lawrence T. Frymire, Executive Secretary
Bureau of Audio-Visual and	Television Advisory Committee
School Library Education	State of California

Chapter I

INTRODUCTION

So much has been written about the benefits derived from television that the school administrator is interested in investigating the use of television in instruction.

There are advantages to be gained by the use of television, but there are also problems that school systems must avoid when applying television to their situation.

Television is a unique tool that can be used effectively. Television will not improve unimaginative teaching nor will it hold the attention of students when the subject matter is dull or uninspiring. The fact that a program is presented on the television screen does not necessarily improve the quality of the program and, in many instances, may bring out the negative rather than the positive properties.

Great care must be taken in the selection of the personnel who appear on television. All teachers in a school system are not necessarily able to project as a television teacher. The personnel who appear must relate well to the audiences to whom they are speaking.

A televised class session requires a most careful analysis of the objectives of the lesson, arrangement of subject matter to illustrate each objective, and how the lesson is finally presented.

Most school systems, with limited budgets, are simply not in a position to produce high quality television courses. To produce an inadequate television lesson and record it on a video tape machine may decrease the effectiveness because of limitations of technical skill in the use of the recording equipment. The production of television lessons by a school system is a complex operation and should be delegated to people who are experts in the field and who have the necessary equipment. Schools wishing to make use of television in their teaching program must, therefore, either use programs available to them over the local broadcast television channels or reproduce their own programs in their schools by means of a video tape recorder or use material obtained from a tape library. In any event, the school systems are increasingly dependent on a means to reproduce video material from video tape.

A very important consideration in the matter of video tape recorders is making satisfactory dubs or second generation tapes. The errors, such as frequency response, increase not in an additive fashion, but in an exponential fashion or by multiplication. That is, if there is a 50% drop in frequency response at 2 MHz, the second generation or first dub will show a 25% frequency response. Phase-shifts, on the other hand, are purely additive. The combination of errors introduced in the second generation in a machine that may multiply so rapidly that the dubs made from the master become virtually useless. It is, therefore, necessary to keep the quality of the tape recorder which will be used for making copies at the highest level of perfection possible in order to be able to produce satisfactory copies of the video tape.

It is hoped that this report will be of some help to administrators who are planning for the use of television, and particularly video tape recorders, in their educational programs.

Chapter II

AVAILABILITY OF INSTRUCTIONAL TELEVISION MATERIAL

For a school district that does not contemplate producing all of its own material, it is helpful to investigate the availability of instructional television material for the video tape machine under consideration. Questionnaires were sent out to the major production centers and distributing libraries in the United States to determine the medium by which their material is distributed: 16mm film or tape for quadraplex or helical-scan. No attempt has been made to assure full and complete coverage of the existing production centers.

In addition to the material that is available as indicated in this report, certain of the educational material distribution centers act as a recording-duplicating facility and will make tape available for any machine. The Great Plains Regional Instructional Television Library of Lincoln, Nebraska, operates in this manner and presently has the quadraplex, Ampex 660B, Dage, Sony 200, and Ampex VR7000 machines. Schools may request tapes for other machines by paying the expenses involved in rental of the video tape machine plus the recording fee.

Additionally, it should be noted that many school districts can arrange with broadcasting stations to record programs off-the-air. Most educational stations offer this type of service to school districts for a nominal fee.

INSTRUCTIONAL TELEVISION MATERIAL
IS AVAILABLE FROM THE FOLLOWING SOURCES FOR THE MACHINES CHECKED

NAME OR PRODUCTION CENTER OR DISTRIBUTING LIBRARY	16mm FILM	QUADRA-PLEX	AMPEX 660B	OTHER
California				
KCET - Channel 28 Community TV of Southern California 1313 North Vine Street Los Angeles, California 90028		X		
KQED - Channel 9 525 4th Street San Francisco, California 94107		X		
KTEH - Channel 54 70 West Hedding Street San Jose, California 95110		X		
KVIE - Channel 6 P. O. Box 6 Sacramento, California 95801		X		
Los Angeles City Schools 1061 Temple Street Los Angeles, California 90012		X		
Pasadena City Schools 351 South Hudson Avenue Pasadena, California 91109		X		Ampex VR-7000
Regional ETV Advisory Council 155 West Washington Boulevard Los Angeles, California 90015				
San Diego State College San Diego, California 92115		X		
Valley Instructional Television Assoc. c/o KVIE - Channel 6 P. O. Box 6 Sacramento, California 95801				
Western Radio & Television Assoc. 633 Battery Street San Francisco, California 94111				Sony EV-200
Florida				
WUFT-TV University of Florida Gainesville, Florida 32603		X		
WFSU-TV Florida State University 202 Dodd Hall Tallahassee, Florida		X		

NAME OF PRODUCTION CENTER OR DISTRIBUTING LIBRARY	16 mm FILM	QUADRA-PLEX	AMPEX 660B	OTHER
Illinois				
WSIU-TV Southern Illinois University Carbondale, Illinois 62903		X		
Indiana				
NAEB/ETS Program Service Bloomington, Indiana 47402		X		
Midwest Program, Airborne Television Instruction, Inc. Purdue University Lafayette, Indiana		X		
National Center for School & College TV Bloomington, Indiana 47402		X		Sony EV-200
Maine				
WMEB-TV University of Maine Orono, Maine 04473	X	X		
Massachusetts				
Commission on English Boston, Massachusetts	X			
Heath DeRochemont Corp. Boston, Massachusetts	X			
Northeastern Regional Instructional Television Library Cambridge, Massachusetts		X		
Michigan				
University of Detroit Detroit, Michigan		X		
Minnesota				
College of Saint Teresa Winona, Minnesota	X			
KTCA-TV 1640 Como Avenue St. Paul, Minnesota 55108	X	X		
Minneapolis Public Schools Minneapolis, Minnesota		X	X	
Nebraska				
Great Plains Instructional Telev. Lib. University of Nebraska Lincoln, Nebraska		X		Ampex VR-7000 Sony EV-200
KUON University of Nebraska 40th and W Streets Lincoln, Nebraska 68501	X	X	X	Ampex VR-7000 and will make dubs for any other machine

NAME OR PRODUCTION CENTER OR DISTRIBUTING LIBRARY	16 mm FILM	QUADRA-PLEX	AMPEX 660B	OTHER
New Hampshire				
WENH-TV		X		
Box 2 Durham, New Hampshire 03824		X		
New York				
RAETA Rochester, New York				
University of New York Albany, New York		X	X	Ampex VR-7000
WHNT - Channel 14 Schenectady, New York		X		
WNDT - Channel 13 304 West 58th Street New York, New York 10019	X	X		
Ohio				
Ohio State University Columbus, Ohio	X	X	X	
Oregon				
School District No. 4 Eugene, Oregon		X		
State of Oregon System of Higher Education Corvallis, Oregon		X		
Pennsylvania				
Department of Public Instruction State of Pennsylvania Harrisburg, Pennsylvania	X	X	X	Ampex VR-7000
WQED-WQEX Metropolitan Pittsburgh 4337 Fifth Avenue Pittsburgh, Pennsylvania 15213		X		
South Carolina				
South Carolina ETV Center Columbia, South Carolina		X		
Tennessee				
Memphis Community TV Foundation Memphis, Tennessee	X	X	X	
WDCN - Channel 2 P. O. Box 6188 Nashville, Tennessee 37212	X	X		

NAME OF PRODUCTION CENTER OR DISTRIBUTING LIBRARY	16 mm FILM	QUADRA-PLEX	AMPEX 660B	OTHER
Texas				
KERA - Channel 13 3000 Harry Hines Boulevard Dallas, Texas 75201		X		
KLRN Southwest Texas Educational TV Council Austin, Texas		X		
KUHT - Channel 8 4513 Cullen Boulevard Houston, Texas 77004		X		
Texas Educational Microwave Project University of Texas Austin, Texas		X		
Washington				
KCTS-TV - Channel 9 University of Washington Seattle, Washington 98105		X		
School District No. 1 Seattle, Washington			X	
University of Washington Seattle, Washington 98105	X	X		
Washington, D. C.				
WETA - Channel 26 Washington, D. C.		X		
Wisconsin				
WHA-TV 3313 University Avenue Madison, Wisconsin 53706		X		
Wisconsin School of the Air Madison, Wisconsin	X	X	X	

Chapter III

COST OF KINESCOPE RECORDINGS

A large number of firms in the United States are in a position to reduce video tape to kinescope recordings. The resulting kinescopes can be projected on a conventional motion picture projector and can likewise be used for television presentations.

Typical among the companies engaged in this function are Technicolor Corporation of America, 823 North Seward Street, Hollywood, California, and Acme Film Laboratories, Inc., 1161 North Highland Avenue, Hollywood, California. While their prices change without notice, current available costs of transfer services are approximately as follows:

Tele View Recording Services, Inc.

Single System Sound/16 mm Negative and One Print	
10 minute transfer	93.56
15 minute transfer	113.36
30 minute transfer	171.00
60 minute transfer	341.56

Double System Sound/16 mm Negative-Separate Track and One Print	
10 minute transfer	121.28
15 minute transfer	153.68
30 minute transfer	248.00
60 minute transfer	495.28

16 mm Release Prints	
1 minute	4.00
5 minutes	10.00
10 minutes	17.50
15 minutes	25.00
30 minutes	50.00
60 minutes	95.00

Acme Film Laboratories, Inc.

Transfer Video Tape to 16 mm Film Direct Positive

1-10 minutes	9.50 per minute
11-20 minutes	7.50 per minute
21-44 minutes	6.00 per minute
45-60 minutes	5.50 per minute
Minimum Charge	50.00

Transfer Video Tape to 16 mm Film Single System
(Includes composite negative and one print)

2-10 minutes	10.50 per minute
11-20 minutes	8.50 per minute
21-44 minutes	7.50 per minute
45-60 minutes	6.50 per minute
Minimum Charge	50.00

Transfer Video Tape to 16 mm Film Double System
(Includes picture negative, RCA Area Track Negative and one print)

2-10 minutes	12.00 per minute
11-20 minutes	10.50 per minute
21-44 minutes	9.50 per minute
45-60 minutes	8.50 per minute
Minimum Charge	60.00

Chapter IV

THE RECORDING SYSTEM

There are several separate and identifiable factors necessary to produce a satisfactory recorded television program. These include the studio facility, the studio camera, the studio mixing equipment, the video tape, the video tape recorder, the television playback equipment, and the television receiver.

In order to produce a professional quality television lesson, it is necessary to provide for the necessary high lighting level (see appendix A) with adequate attention to such factors as back lighting, uniformity of front lighting, visual aids, and rear screen projectors.

This report will not deal with television cameras per se, but the successful television production facility should be equipped with a camera capable of producing a resolution which is in excess of the capability of the television receiver. The difference in cost of a low quality Vidicon television camera with resolution in the order of 300 to 400 lines and a camera with adequate resolution is so little that the studio should not be handicapped by having an inferior camera. Many manufacturers are presently able to offer cameras with resolution of 700 lines in the center and 500 to 600 lines in the corners--resolution which exceeds that of the other pieces of equipment in the complete system.

The art of manufacturing of video tape has reached a point at which video tape generally is no longer the limiting factor in the production center. At least three highly reliable manufacturers of video tape can furnish any type of video tape as required by the various models of video tape recorders.

Video tape is manufactured with the magnetic granules laid lengthwise or perpendicular to the video tape. T he magnetic properties of the primary magnets laid down on the tape are affected by the direction in which a magnetic field is applied when the tape is manufactured. One orientation of the magnetic material is designed for the quadraplex machine where the magnetic line is perpendicular to the tape and the other is designed for the helical-scan machines where the magnetic track is laid in a direct slant across the tape, (but generally in a longitudinal direction).

In the early production of video tape, manufacturers were plagued by minute areas on the tape that were not covered by the iron oxide coating. This coating, less than a mil thick, must be spread absolutely uniformly with no pinpoint holes larger than the tip of a needle. A hole in the oxide coating one micron in diameter (one millionth of an inch) produces an objectionable white smear for an appreciable part of a scanning line, probably 2% of the screen width. This phenomenon is known in the television industry as "drop out" and manufacturers guarantee tape in terms of how many drop outs per second the tape contains. Drop outs are undetected until a signal is recorded and played back. Consequently, manufacturers do not generally detect drop outs in tape except in select reels that are used for quality control.

Additionally, manufacturers are now coating the oxide side of the video tape with an extremely thin layer of plastic. The iron oxide used in video tape is an exceptionally hard and abrasive material and the thin plastic coating does much to decrease the head-wear as the recorder's video head rubs across the oxide coating. The recording level must be increased by 10% to 15% when the video tape machine is using plastic coated tape. The state of the art of the production of video tape is such that television programs reproduced from tape are not limited by the video tape.

The limiting factor in installations using the best recording techniques and equipment is the television receiver. While it is possible to purchase television monitors that can exhibit a resolution of 600 lines per inch, the cost of such monitors is so high that most educational institutions will choose to purchase readily available economy models of broadcast television receivers. Receivers in this category are available for UHF, VHF, and for a direct video input.

The standard television set with a video input is a relatively new item on the commercial market. Television installations have long "jeeped" television sets for a video input. This is done by adding a switch in the first video amplifier and switching this to a terminated 75 ohm video input line. The resulting level to the first video amplifier is of the order of .5 to 2 v. p-p, and this generally is not sufficient to provide adequate contrast. All commercial models frequently add a stage of amplification to raise the standard video input signal to the proper level before switching into the video circuit.

The electronics and the television cathode ray tube are the limiting factors in a standard television receiver. The economy line of receivers will reproduce from 300 to 325 lines at the center of the picture, and this should be the practical limitation placed on resolution for educational purposes.

The last factor in the resolution and fidelity of the video program is the video tape recorder. The video tape recorder is required to transform the video picture signal to a suitable magnetic signal which places a series of north and south magnetic poles along a narrow strip of magnetic iron oxide on the video tape. The width of the magnetic track is from 5 to 10 mils (1/1,000ths of an inch). A similar very narrow guard band separates one pass of the video recording head from the subsequent track.

In the case of the quadraplex video tape recorder, a single pass of the recording head perpendicularly across the video tape records 16.4 lines of picture information. The next head on the four-pole rotary assembly records the next 16.4 lines until the entire raster of 525 lines has been recorded.

In the case of the helical-scan, generally the entire first field consisting of 262.5 lines is recorded in one pass of the head across the tape at the slant angle. The actual path length obviously varies with the width of the tape and the angle that the head makes with respect to the longitudinal direction of the tape. The second pass of the head records the remainder of the 525 lines that form the interlace second field.

In addition to the magnetic islands that are deposited on the video tape by the recording head, a minimum of two additional tracks must be recorded by the machine. One track will contain the audio information (and the techniques are identical to those of the standard audio tape recorder). The second track contains information which controls the speed of the playback recorder so that the position of the tape will be synchronized exactly with the position of the video pick-up head. This is naturally a requirement so that the playback head will retrace the precise path made by the recording head.

The total frequency spectrum required to reproduce a satisfactory television picture is from 60 Hz (Hertz) to 4 MHz (megaHertz). The electrical signals are converted to magnetic fields by the recording head, and the oxide coating retains a portion of the magnetic field as distinct areas of north and south poles. On playback, the north and south poles successively pass under the playback head causing a magnetic field to be set up through the playback coils. This in turn, produces an electrical signal.

The electrical signal obviously must faithfully represent the original electrical field containing the video information.

Since the electrical field generated by a changing magnetic field is proportional to the rate of change of flux, there is an inversely proportional voltage versus frequency produced by the magnetic fields. That is, as the frequency decreases, the strength of the residual magnetic poles must increase if the voltage produced in the recording head is to remain constant. Since the video frequency varies by a factor of 50,000 to 1, the magnetic field must also vary by this ratio. It is thus virtually impossible to record video information directly, and to solve this dilemma it is necessary to convert the video electrical information into a frequency modulated signal.

Since in frequency modulation the electrical signals are represented by the rate of excursion of the frequency from the carrier frequency, low frequencies can be reproduced without changing the frequency of the recorded signal appreciably. The nominal carrier frequency in most systems is close to 3 megahertz, and the frequency modulating system varies the frequency above and below this by a limiting amount, thereby assuring that the electrical voltage reproduced by the recording head is essentially constant. The rate at which the frequency varies determines the resulting demodulated frequency of the video signal, and the amount of the excursion above and below the carrier frequency determines the amplitude and polarity of the reporduced video signal. The type of frequency modulation used in the video tape recorder varies from recorder to recorder.

Most of the video tape recorders have separate modulators and demodulators built into the electronics. To assure that the electronics is working properly, a loop-through arrangement is provided which does

not involve the record-playback heads but includes the modulation and demodulation circuits. This output is arranged so that it may be monitored during recording to assure that the signal is being properly routed through the modulator; it being impossible to provide an immediate playback without duplicating the entire complex video record-playback head system.

Chapter V

THE PRINCIPLES OF TESTING VIDEO TAPE RECORDERS

The ideal video tape recorder must reproduce video signals while maintaining the input amplitude and phase relationship.

Specifically, this means that the amplitude of the reproduced signal will vary exactly as the input video signal for all frequencies in the television video spectrum. It further means that the phase relationship between all signals shall remain unaltered in passing through the recording process.

The television industry has developed a number of tests that can well be applied to video tape recorders. A series of three simple tests will give information on the fidelity of the television system. These three tests are referred to as the multiburst or sine-wave frequency test, the window test, and the stairstep test.

The Multiburst Test

In the multiburst test, a series of sine-wave signals of constant amplitude but variable frequency are fed into the video tape recorder The multiburst used in the test is a set of seven gated discreet intervals consisting of a white flag or window followed by six pure sinusoidal frequency bursts of 0.5 MHz, 1.5 MHz, 2 MHz, 3.2 MHz, 3.6 MHz, and 4.2 MHz locked to line time. Each sinusoidal frequency burst occupies approximately eight microseconds and is adjustable in the signal generator so that the amplitude of each sinusoidal burst can be kept constant.

The reproduced multiburst will yield the amplitude/frequency response of the system. When the signal output is down to 70% of the original signal, it is down 3 db. A drop in signal to 50% is down 6 db.

The Window Test

The window test signal consists of approximately 30 microseconds of 100% modulated (white) signal level held constant over the period. Only 150 lines toward the bottom of the television picture is affected. As seen on the "A" scope, the window is a pure white rectangle occupying approximately one-fourth of the lower left side on a dark screen. The black portion of the screen is held at blanking level and the white portion is held at 100% modulation level. The reproduced picture should be perfectly uniform in intensity over the entire region with neither trailing black nor white at the left or right edges of the rectangle.

The Stairstep Test

The stairstep test consists of ten discreet constant signal levels occupying the entire picture frame. The highest level is adjusted to 100% modulation (white) and the lowest level is at blanking level.

This test determines the overloading characteristic of the system and the reproduced signal should increase at the same ratio as the output of the test generator. Each portion of the stairstep pattern should be a degree of pure gray level on the "A" scope starting with a black level and progressing to pure white or 100% modulation. Error in aperture can be estimated by laying a ruler along the stairstep pattern and estimating the deviation of the leading edges of the pattern from a straight line.

Calibration photographs taken with the waveform monitor are reproduced in this report for each machine under test. This was done to provide simple comparison between the calibration test signals and the signals from the equipment under test. Figure 1-1, Figure 1-4, and Figure 1-7 are examples of the three input test signals.

Chapter VI

ANALYSIS OF WAVEFORM OUTPUT TEST PHOTOGRAPHS

Figure 1 shows a typical high frequency roll-off as depicted by the fact that the third, fourth, fifth, and sixth multiburst patterns are regularly decreasing in amplitude. This high frequency roll-off was produced by introducing a low-pass filter which decreased the amplitude of the signal as the frequency increased. High frequency roll-off decreases the sharpness of the leading white line on the left side of all objects, and this produces a black smear on the left side of all white objects. It likewise produces a white lag on the right side of all objects, referred to as a trailing white smear.

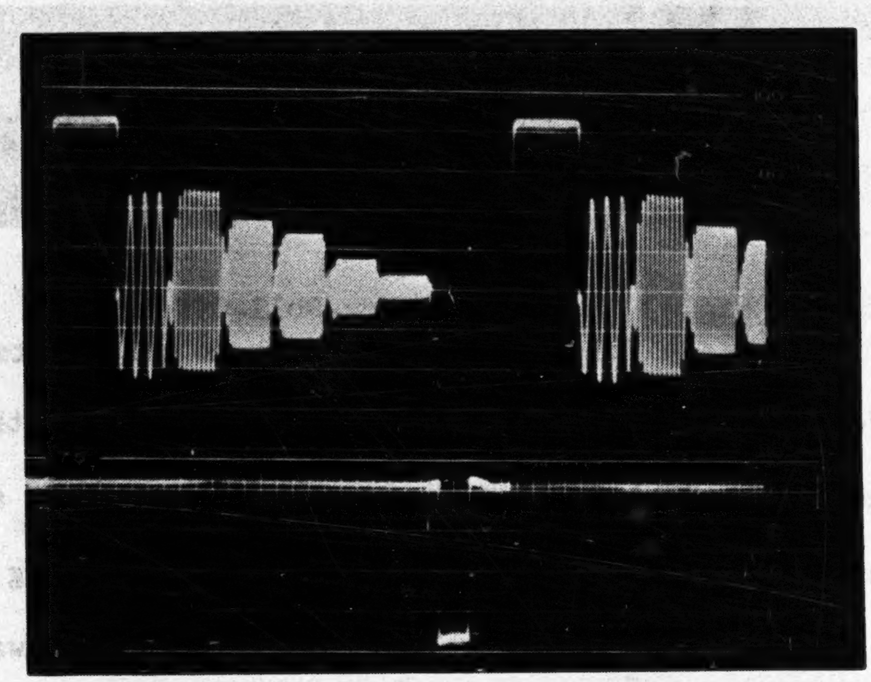


Fig. 1 High Frequency Roll-Off

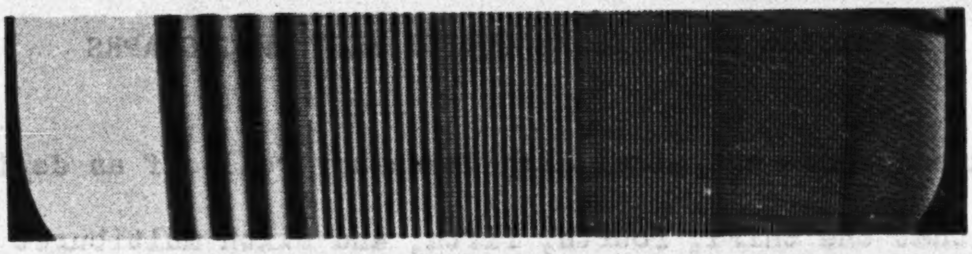


Fig. 2 Standard "A" Scope Display

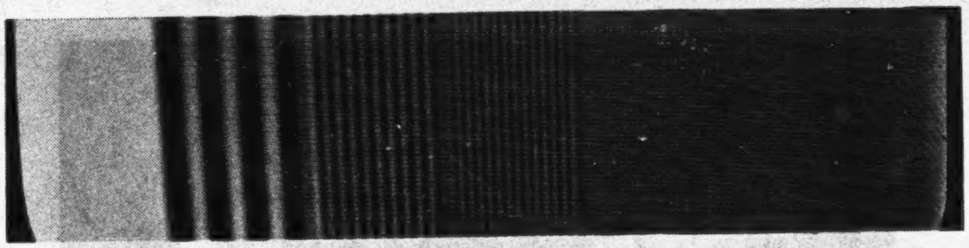


Fig. 3 High Frequency Roll-Off
Note lack of detail on all bursts

On a window, the result is as shown in Figure 4 where the leading edge of the square is significantly rounded at the top left side and where the right side of the window as it approaches blanking level is again significantly rounded off. The sync pulses, the downward portion of the picture, is likewise significantly rounded from the perfectly square pulse patterns of Figure 1-1.

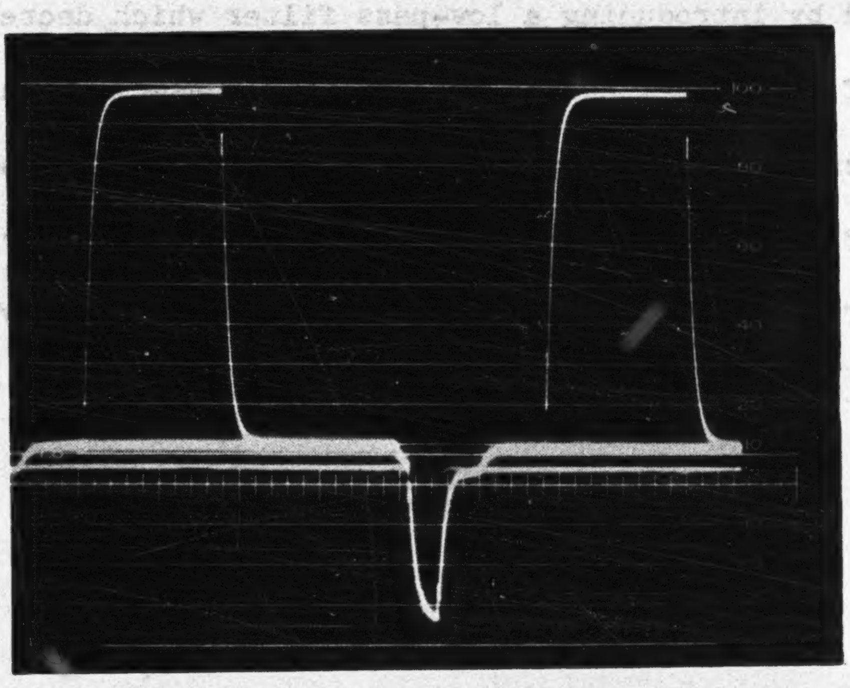


Fig. 4 Waveform of Window With
High Frequency Roll-Off

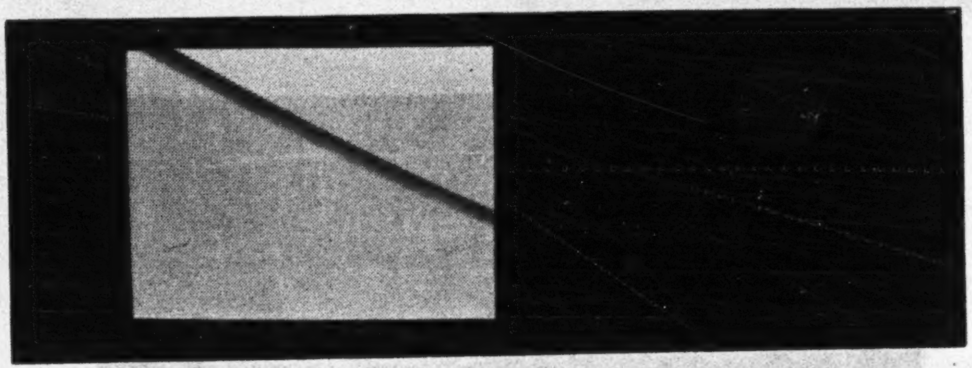


Fig. 6 Normal Window "A" Scope

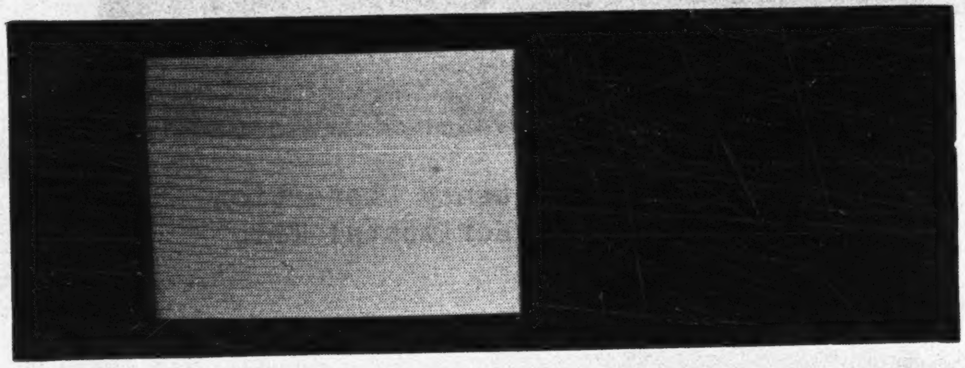


Fig. 7 Window with Black and White Smear
Caused by High Frequency Roll-Off

Low frequency distortion has its greatest effect on the horizontal portion of the window or white flag. Depending on the time constant of the circuit involved, the horizontal bar on the waveform oscilloscope will show under-shoot, over-shoot, or horizontal tilt. For example, a short time constant over-shoot is a negative tilt that is a drop in amplitude from the leading to trailing edge. Figure 8 shows an example of the latter. When viewed on the "A" scope, the gray levels of large areas change toward the dark hues. Over-shoot, on the other hand, outlines the left side of all objects with a white or lighter color ghost.

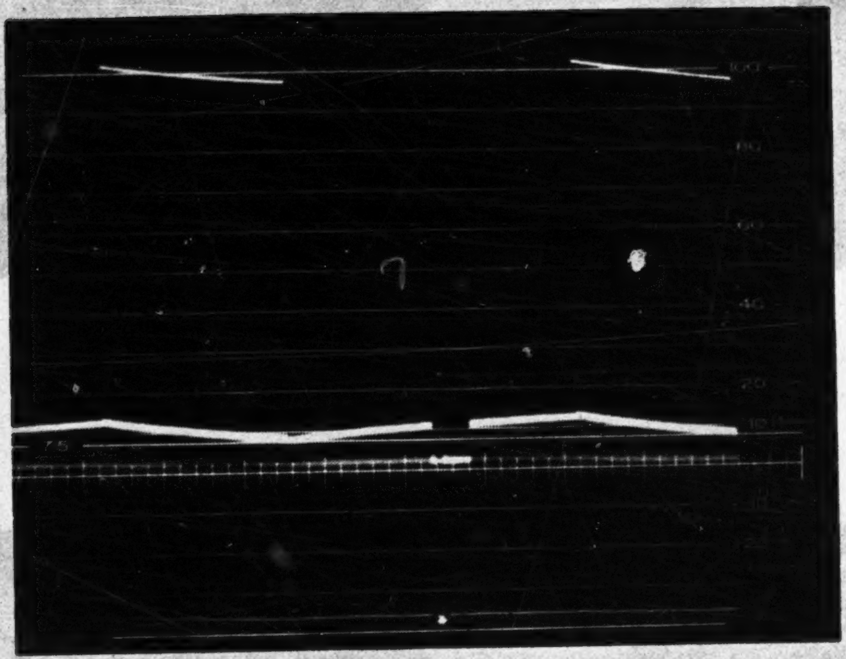


Fig. 8 Low Frequency Distortion Causing Horizontal Tilt

Fig. 9 Window Showing Horizontal Tilt Effect

A third very common type of effect that occurs in a television system is due to echo or multi-signal path in the system. This can be caused by impedance mismatch together with a time delay of some sort. This effect is generally more pronounced at those times where the signal level makes a wide excursion such as immediately after a sharp rise or a sharp drop in level. Figure 10 shows echoes or ringing superimposed on a window. A sharp leading spike precedes the actual damped ringing signal, and this produces a series of ghosts that diminish in brightness as they progress toward the right of the television screen.

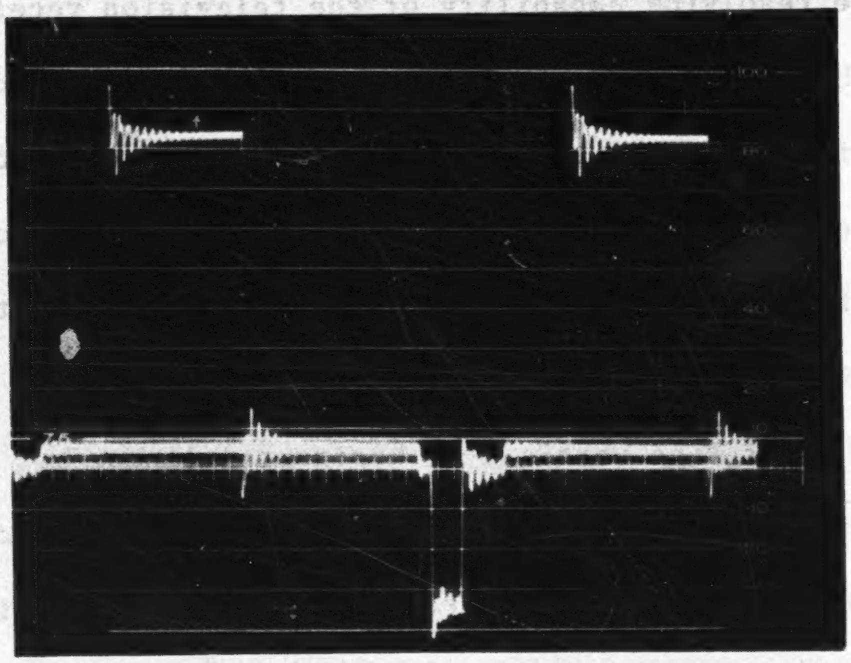


Fig. 10 Echo or Ringing and Over-shoot

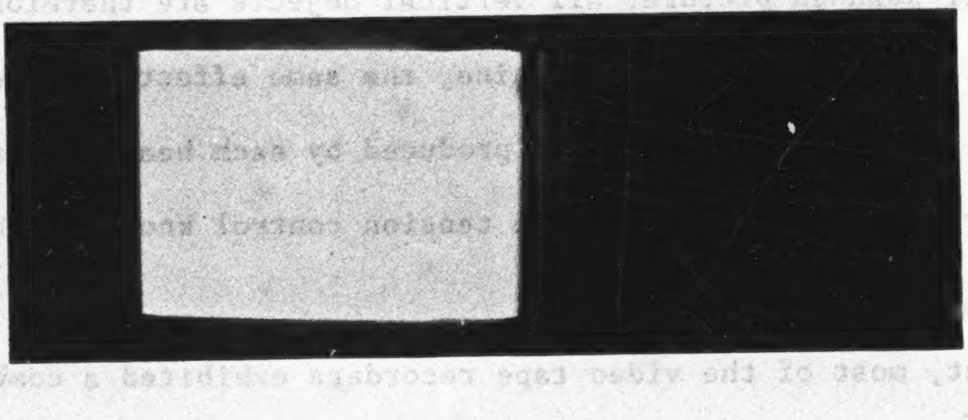


Fig. 11 "A" Scope of Echo and Ringing

A problem common to all video tape recorders is the presence of some unfiltered carrier in the video output. Since the video carrier and the highest frequency to be transmitted by the video tape recorder are of the same order of magnitude, it becomes increasingly difficult to reduce the carrier signal to an acceptable level.

The presence of the carrier frequency on the video signal will tend to blot out the finer details of shading on the picture. It has the effect of reducing the resolving capability of the television receiver. The presence of a high frequency extraneous signal when combined with the video signal will produce a type of distortion known as a moire. Since the high frequency extraneous signal is often produced by some type of oscillation effect in the system that is amplitude dependent, the resulting moire effect will shift and vary with time. This effect is most pronounced on scenes made up of fine vertical or horizontal lines.

The friction between the head and the video tape produces a type of distortion that affects the vertical objects on the television screen. Evidently the head velocity changes slightly during a revolution due to non-uniformity of friction between the head and the video tape. This results in a noticeable "S" shaped curve on the leading edge of the under-scanned picture. Since all vertical lines follow the leading edge of the under-scanned picture, all vertical objects are therefore slightly "S" shaped. In the quadraplex machine, the same effect is noted as the skewing of the successive segments produced by each head. This can be partially remedied by adjusting the tension control known as the skewing control.

In test, most of the video tape recorders exhibited a combination of the above factors, and an attempt has been made to analyze each of the video tape recorders with respect to the errors listed above.

Chapter VII

DESCRIPTION OF TEST SET-UP AND EQUIPMENT TESTS ON INDIVIDUAL MACHINES

Diagram No. 1 shows the test set-up used on the video tape recorders. The sync generator controls the Telechrome test signal generator with the signal looping through the waveform monitor in the A position. The signal then is fed to the modulator. In the record mode, the switch position connects the demodulator to the modulator, and the monitor picture appears on the B position of the waveform monitor. This position makes it possible to check the loop through electronic circuit but not the record-playback head configuration. From the waveform monitor, the signal loops through the "A" scope and the line is terminated in a 75 ohm resistor.

In the playback mode, the function switch in the video tape recorder is as shown on the diagram and only the playback portion of the video tape recorder is activated. This signal feeds through the demodulator, the waveform monitor, and through the "A" scope.

All photographs of the waveform monitor were obtained by means of a Hewlett-Packard Model 196B Polaroid-Land camera.

The photographs of the "A" scope are enlarged 35 mm photographs taken with a Nikon F 35 mm camera. Photographs were printed on high contrast paper to show as much detail as possible.

Since the Nikon camera time setting at 60 cycles almost synchronizes with the playback video signal, a phasing bar appears on each of the photographs from the upper left-hand side to the right side of the photograph. Without perfect synchronization, this is unavoidable. An increased exposure would involve multiple-scanning lines with a possible loss of detail. For this reason, it was deemed desirable to maintain maximum detail and the subsequent phasing bar.

TEST SET-UP

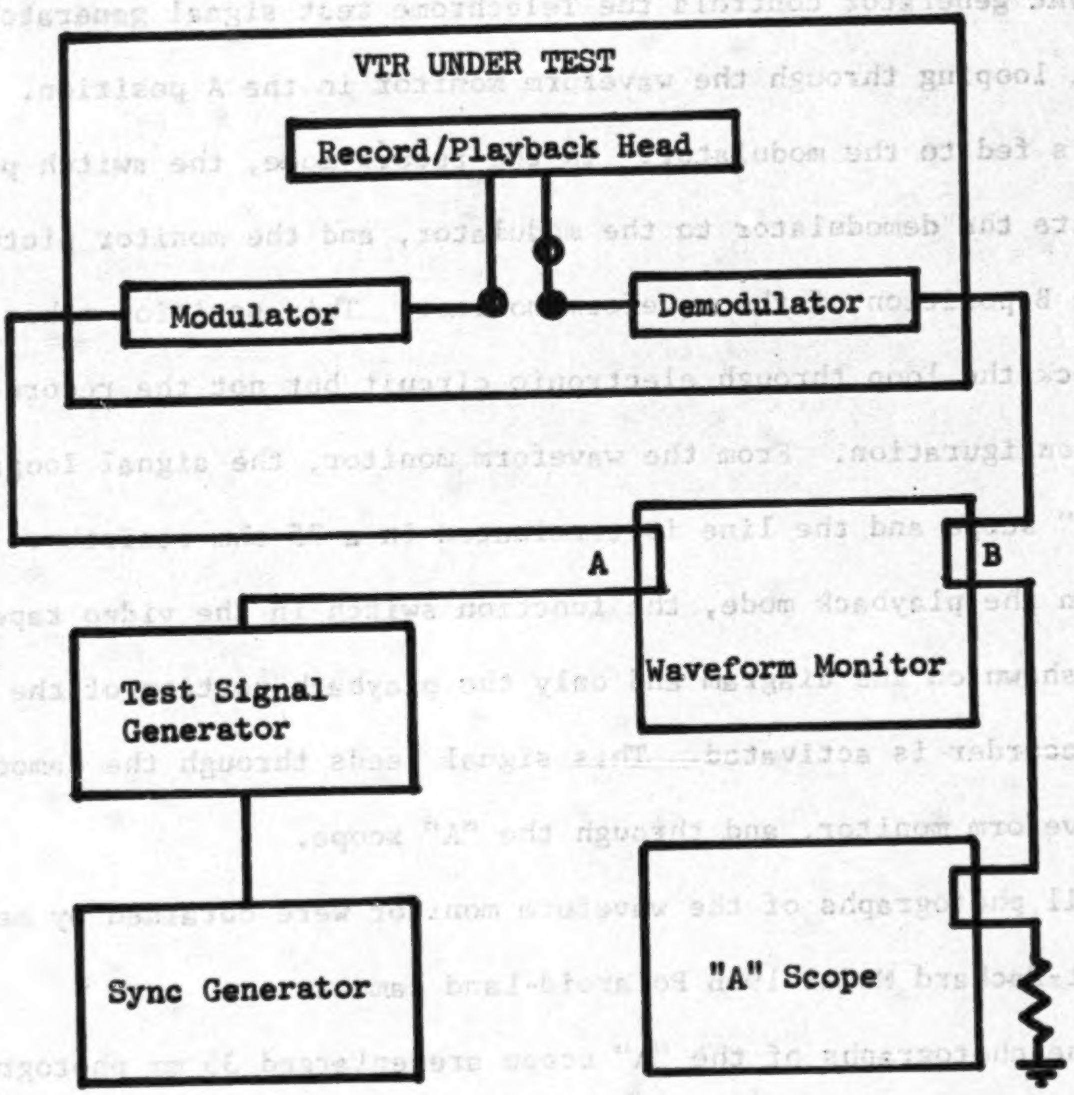

VTR UNDER TEST
Record/Playback Head
Modulator
Demodulator
A
B
Waveform Monitor
Test Signal Generator
Sync Generator
"A" Scope

Diagram 1

EQUIPMENT USED:

Test Signal Generator: Telechrome Model 1003-DIB Video Transmission Test Signal Generator

* Sync Generator: Riker Model 520 Sync Generator

Waveform Monitor: Tektronix RM 527 Waveform Monitor

"A" Scope: Modified High Resolution Video Monitor and Conrac Model CVA-17 Video Monitor

* The Riker Model 520 Sync Generator was loaned for this project by S. S. Krinksy & Associates, 6311 Yucca Street, Hollywood, California

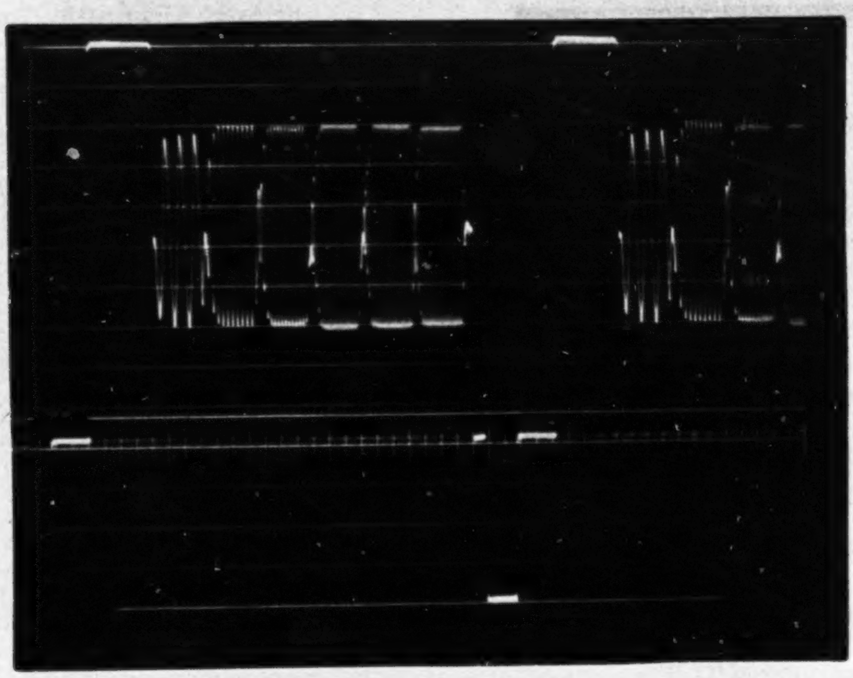


Fig. 1-1 Calibration Multiburst

This is the input signal into the machine before passing through any of the electronics. The flag burst is calibrated to 100%. Multiburst signals are calibrated to 50%.

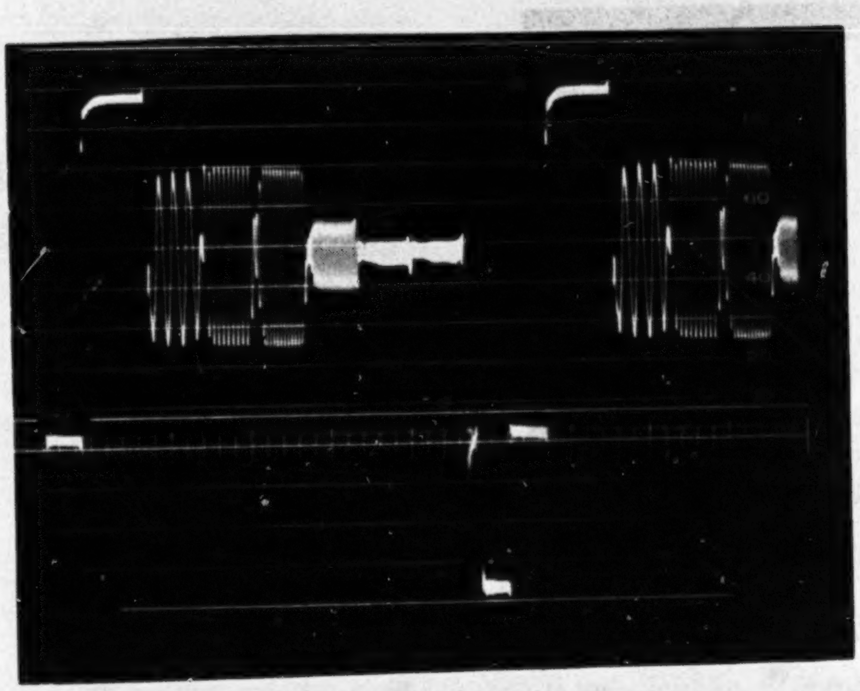


Fig. 1-2 Multiburst Loop-Through

Output level 10% low. Output level starting at 3.2 MHz is reduced to less than one-half its original level. Leading edges of flag indicates high frequency roll-off plus slight ringing.

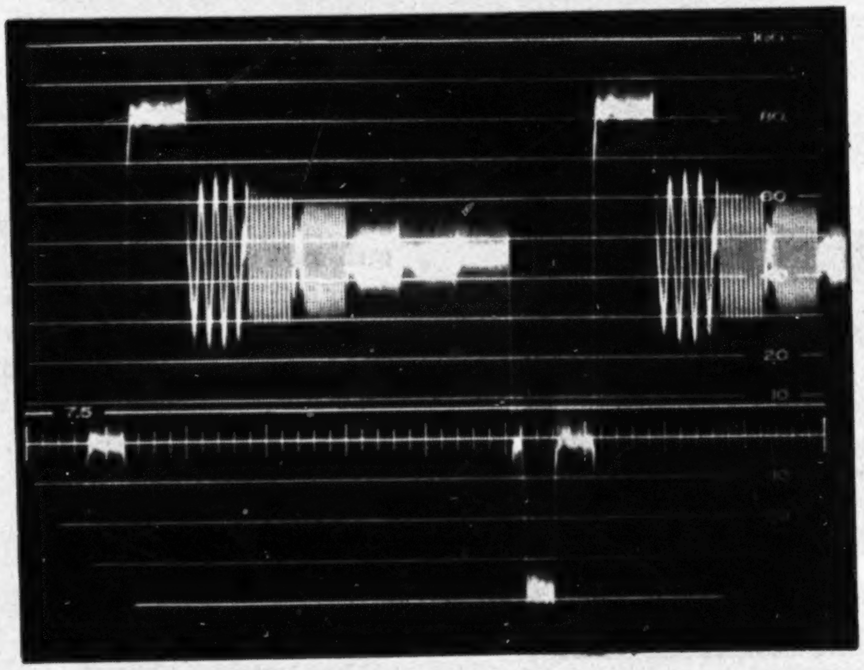


Fig. 1-3 Multiburst Playback

Output level 18% low. High frequency roll-off beginning at 1.5 MHz and is reduced to one-half the original level by 3.2 MHz. Flag and sync signals show definite ringing. Haze in picture shows noise and carrier leak through.

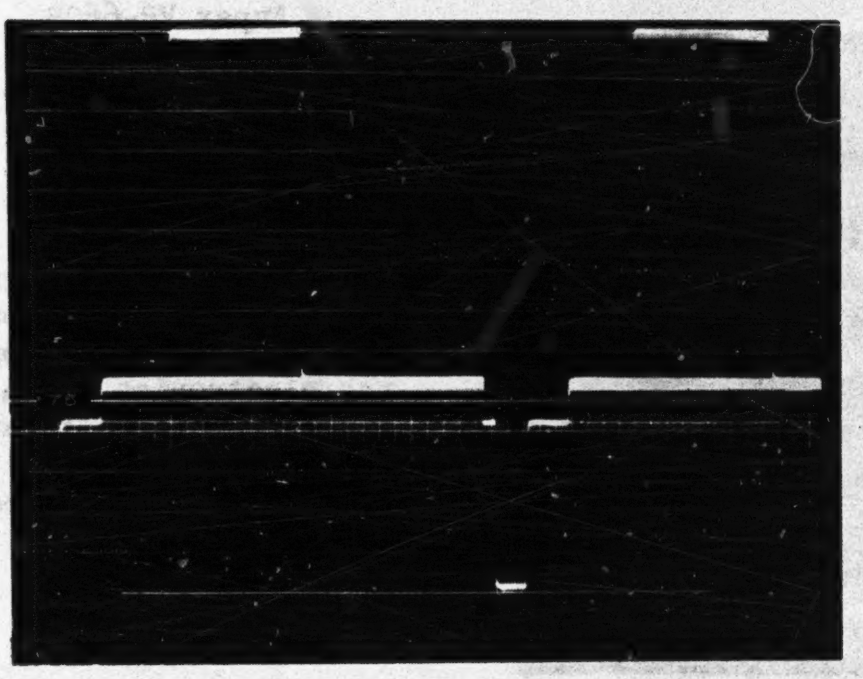
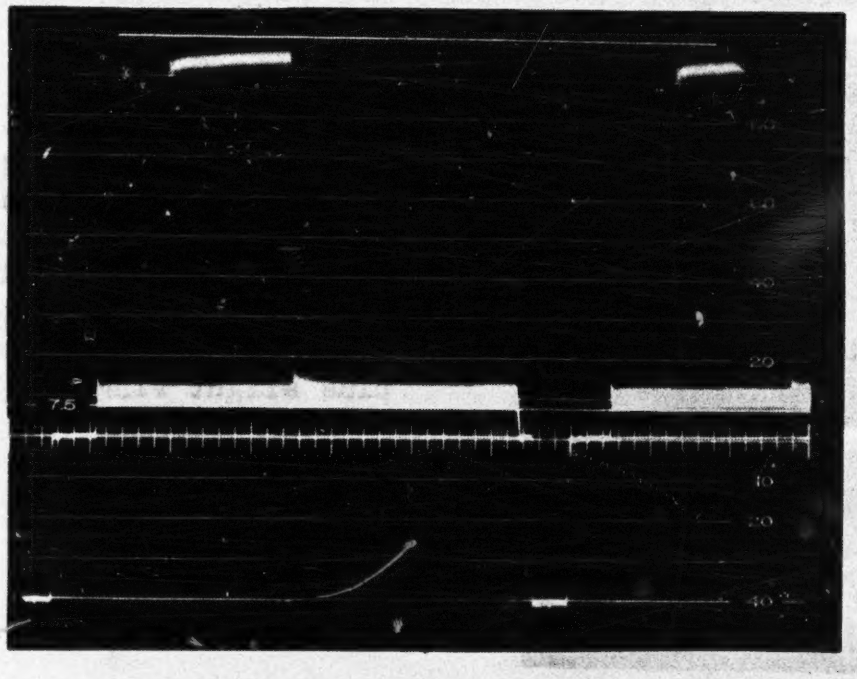
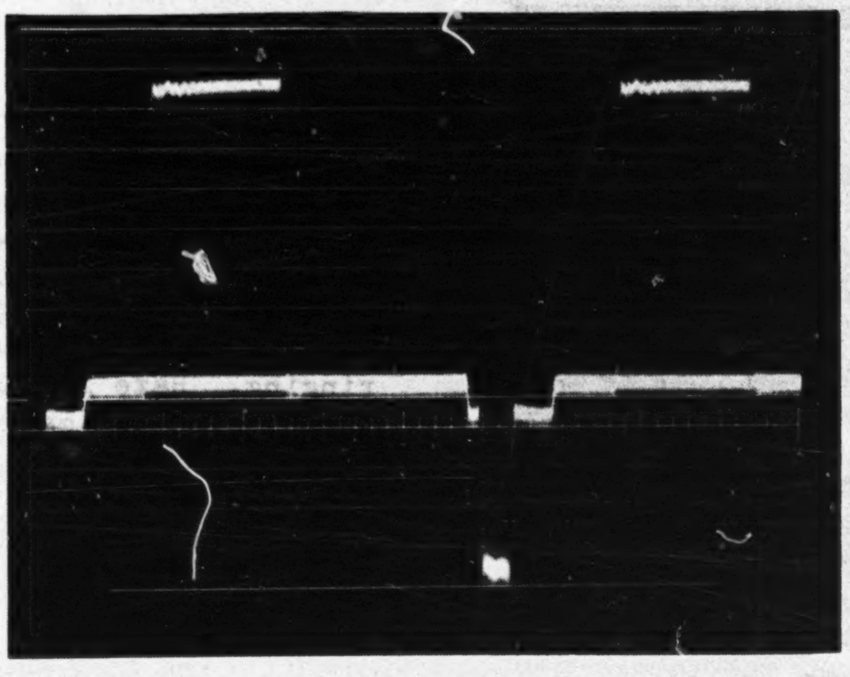


Fig. 1-4 Calibration Window



The output level is 5% low on loop-through with evidence of tilt due to high frequency roll-off.

Fig. 1-5 Window Loop-Through



The output level is 15% low. The window indicates definite ringing but not in excess of 3%. Approximately 3% tilt indicates high frequency roll-off. General noise indicates possible carrier leak through.

Fig. 1-6 Window Playback

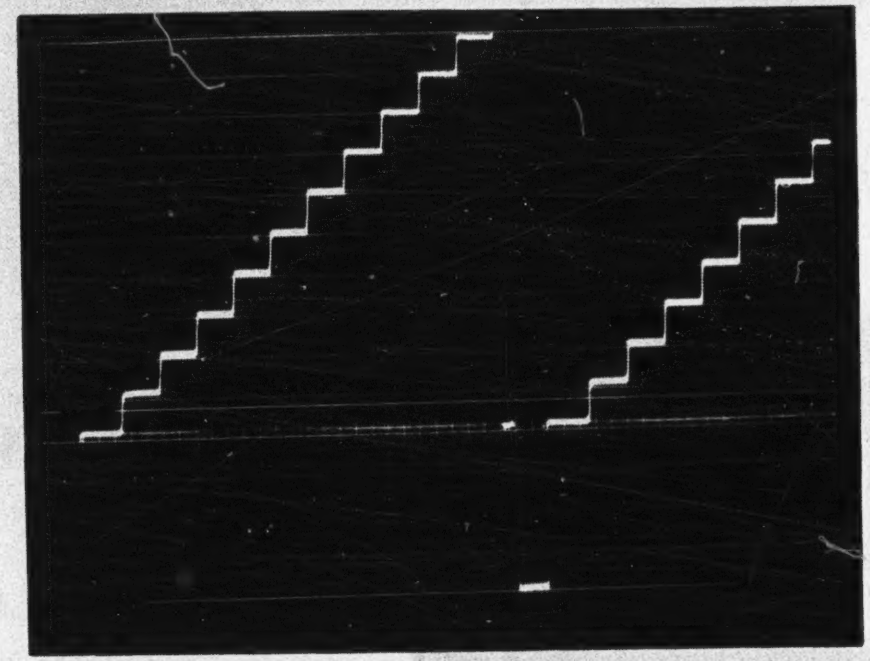
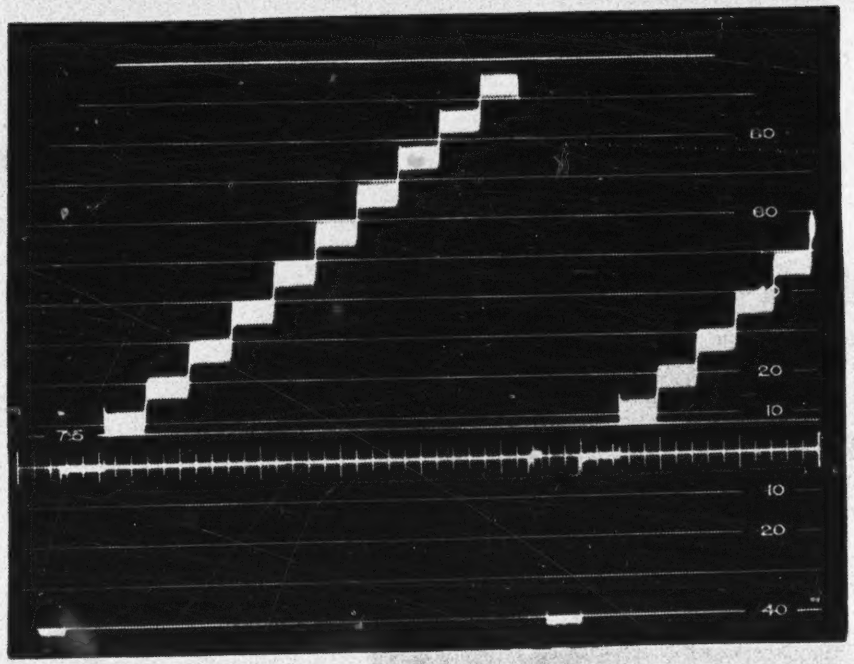
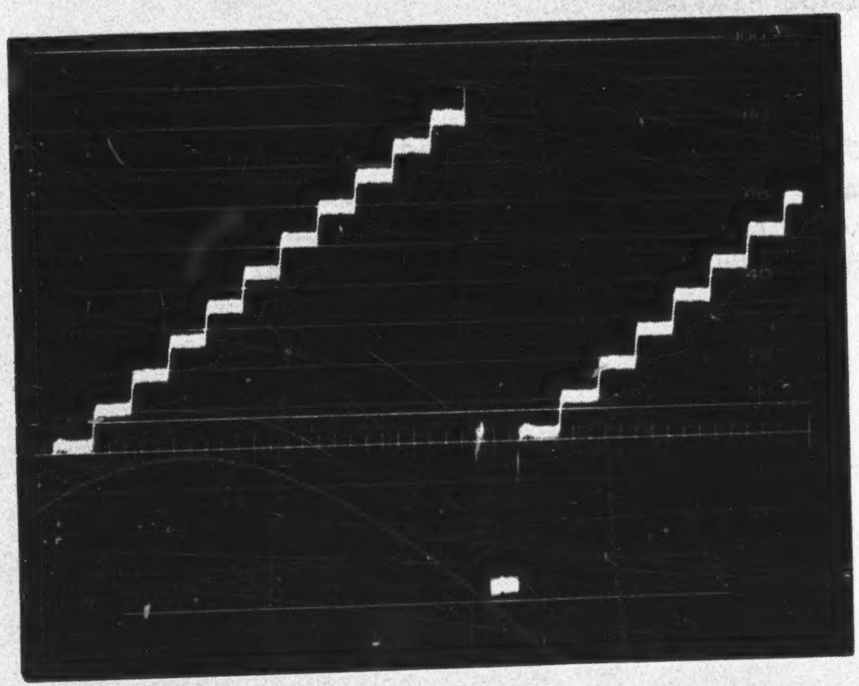


Fig. 1-7 Calibration Stairstep



The stairstep output level is 6% low with indication of slight ringing. It may be noted that the carrier leak through on playback is less than in the loop-through mode.

Fig. 1-8 Stairstep Loop-Through



The output level is 18% low. Slight ringing on all steps. Differential amplitude distortion very low.

Fig. 1-9 Stairstep Playback

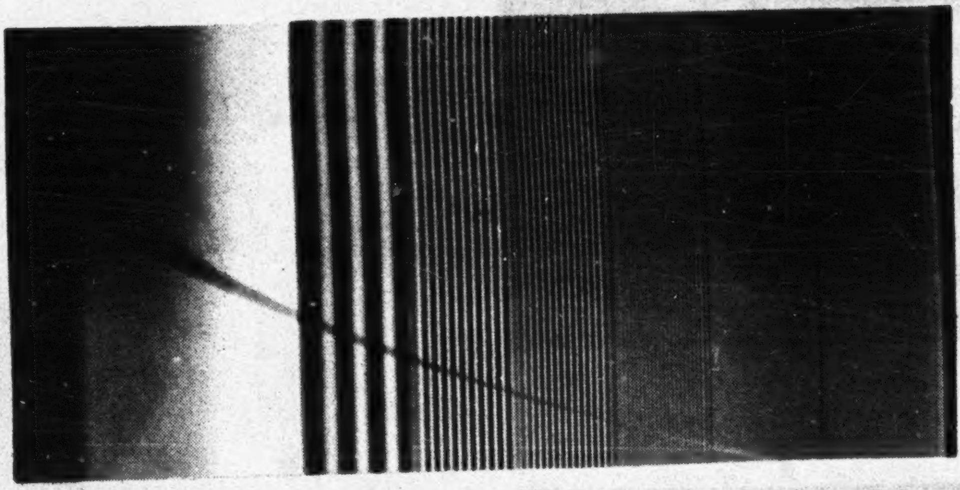


Fig. 1-10 Multiburst "A" Scope Loop-Through

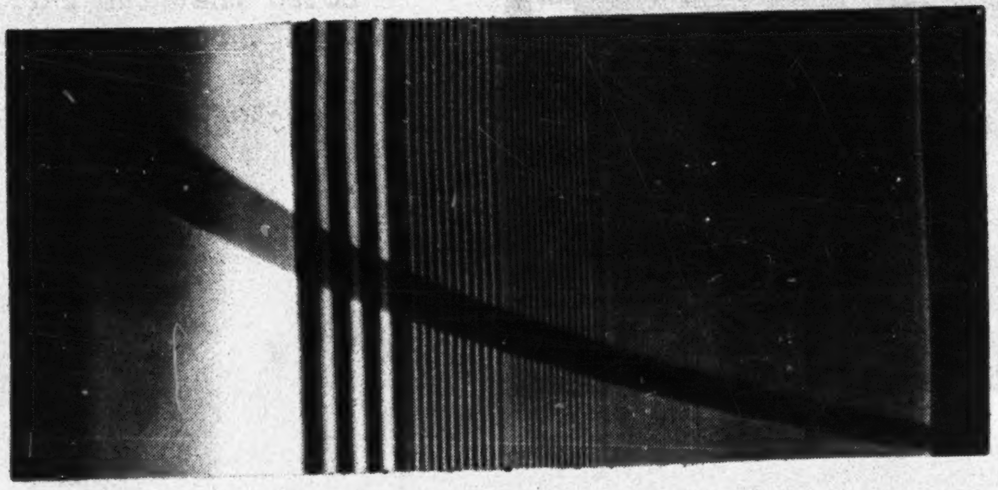


Fig. 1-11 Multiburst "A" Scope Playback

The loop-through response of the Ampex 660B is excellent with good response through the 3.2 MHz multiburst. Some detail is visible in the 3.6 MHz burst. On playback the presence of extraneous signals are visible as moire patterns in the 3.6 MHz burst and interference in the 3.2 MHz burst. This machine has a very low "S" distortion on the vertical bars.

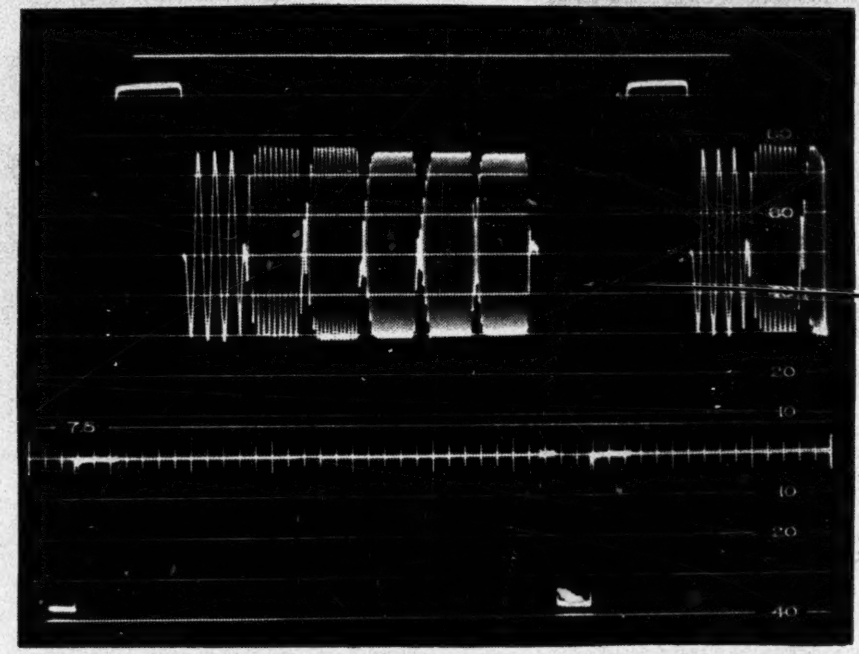


Fig. 2-1 Calibration Multiburst

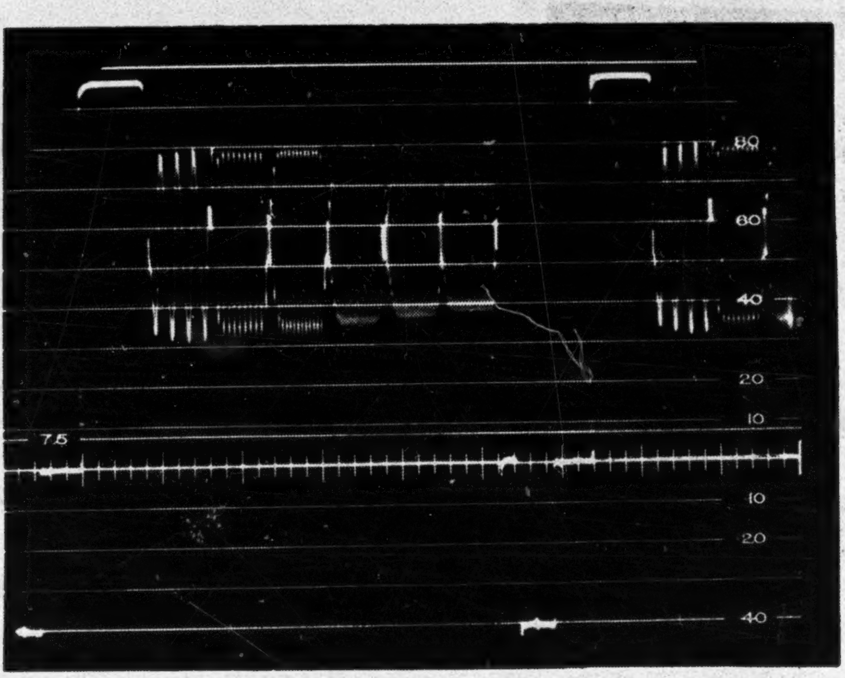


Fig. 2-2 Multiburst Loop-Through

The amplitude and phase relationship are faithfully reproduced through the 3.2 MHz burst with the loop-through signal down not more than 30% at the 4.2 MHz burst frequency.

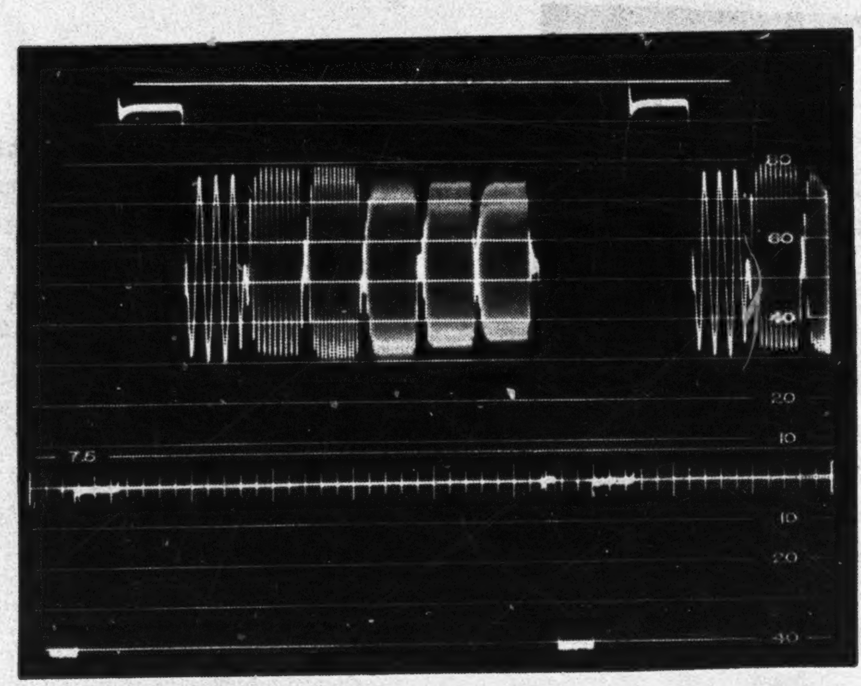


Fig. 2-3 Multiburst Playback

The double pattern in the 3.6 MHz and 4.2 MHz patterns indicate the presence of extraneous signals, probably carrier leak through. The system, however, passes these frequencies with the signal down probably 50% at the highest multiburst frequency.

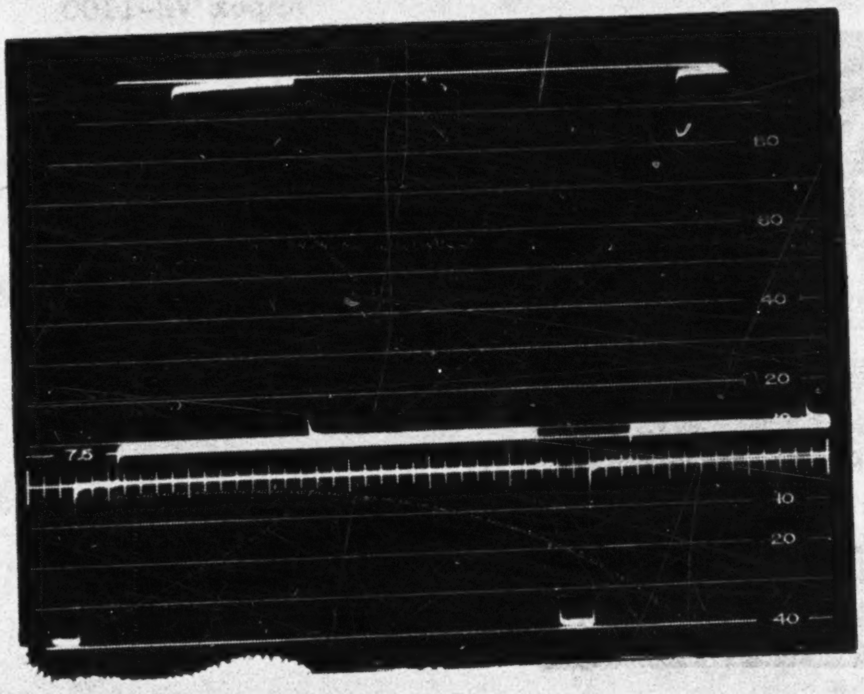
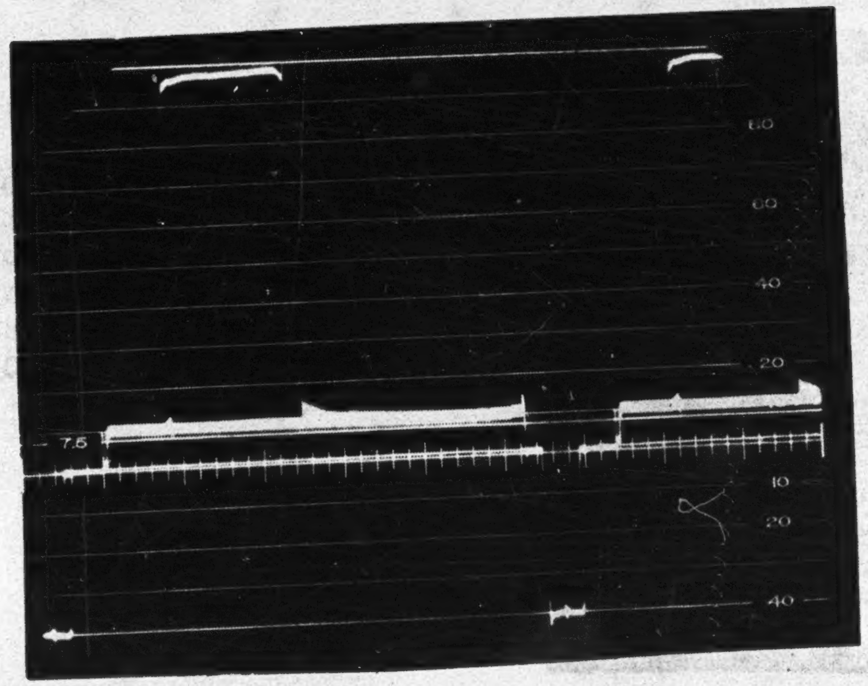
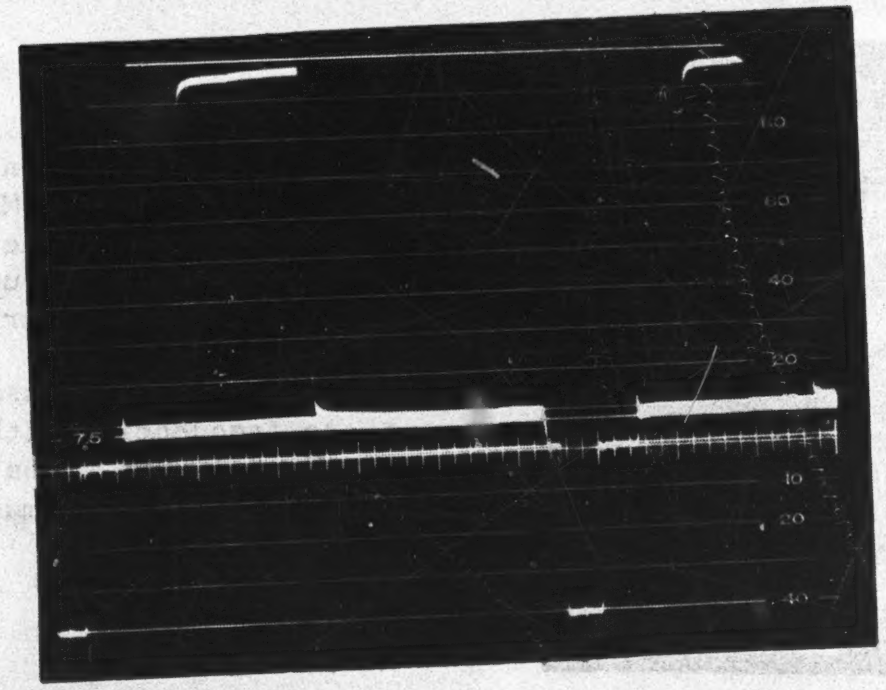


Fig. 2-4 Calibration Window



The electronic circuit on window loop-through indicates over compensation by over-shoot at the trailing edge of the window and over-shoot on the sync pulse. Referring to Fig. 2-6, the window playback, the over compensation is necessary to overcome certain of the playback characteristics.

Fig. 2-5 Window Loop-Through



The leading edge of the window indicates a small degree of high frequency roll-off and probably 3% low frequency tilt. This is an entirely acceptable value in both categories.

Fig. 2-6 Window Playback

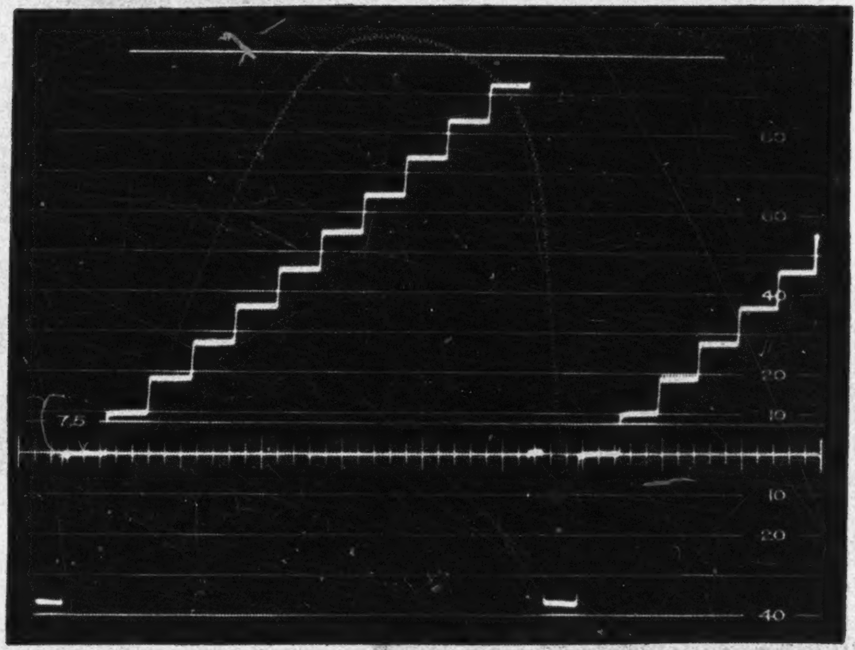


Fig. 2-7 Calibration Stairstep

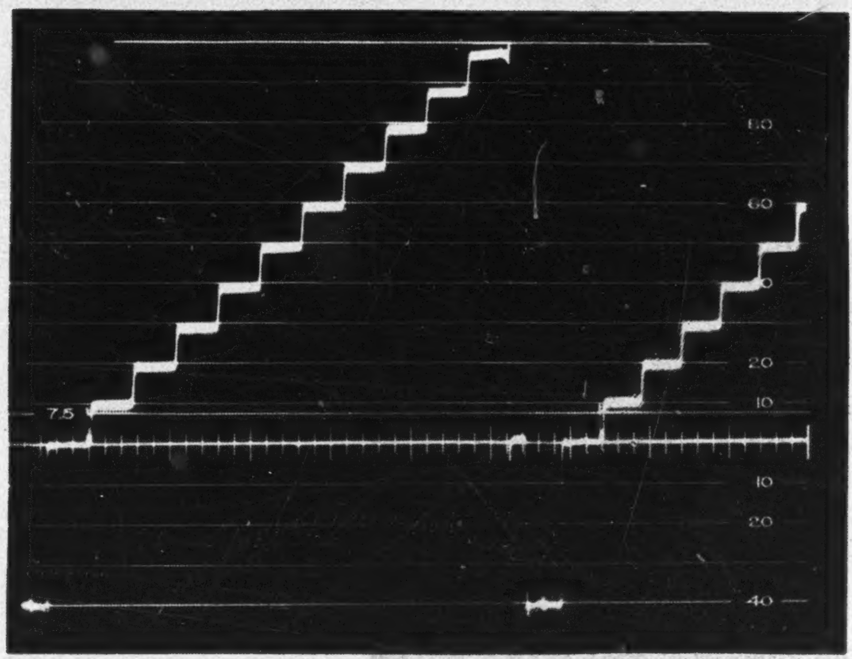


Fig. 2-8 Stairstep Loop-Through

The loop-through stairstep is entirely satisfactory.

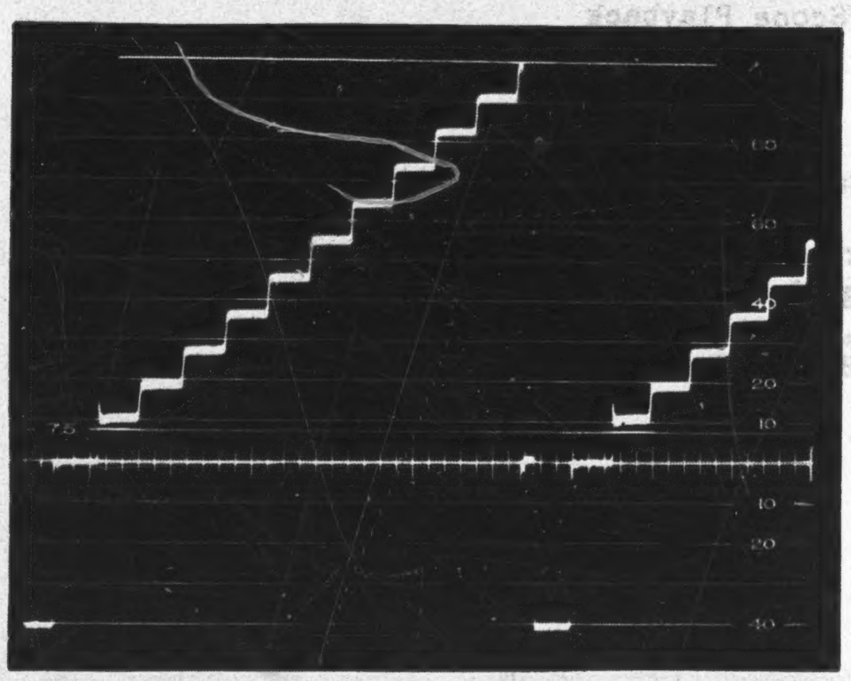


Fig. 2-9 Stairstep Playback

The ~~loop-through~~ playback stairstep is entirely satisfactory and exhibits less than 2% aperture distortion. A straight edge laid along the edge of the stairstep shows that the points come to a perfectly straight line.

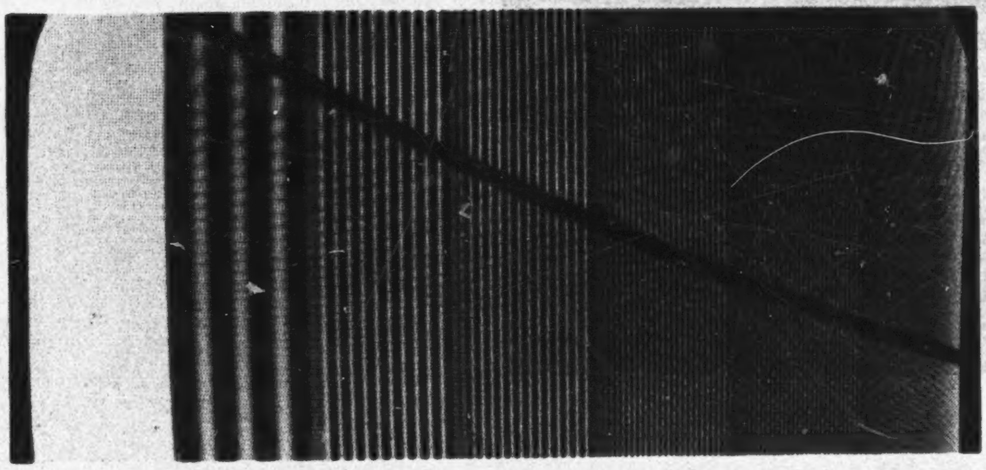


Fig. 2-10 Multiburst "A" Scope Loop-Through

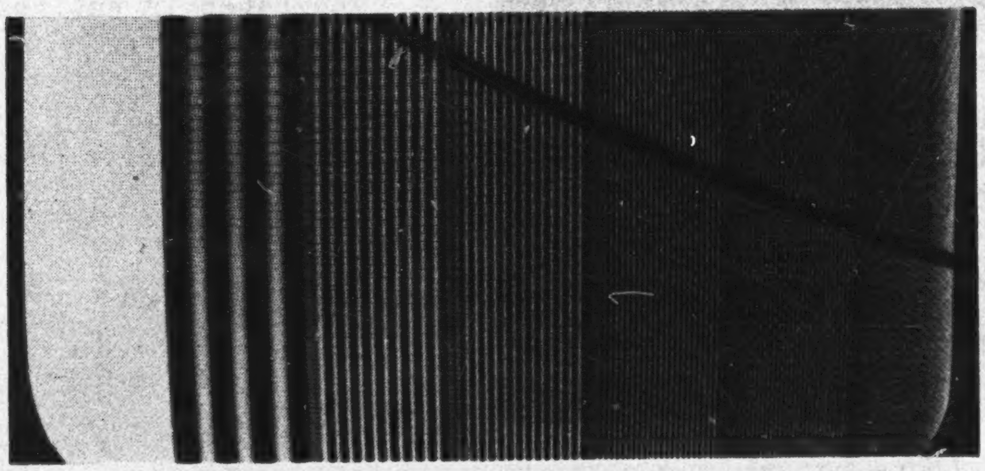


Fig. 2-11 Multiburst "A" Scope Playback

Of the machines tested, the Ampex VR1100 showed the most favorable playback characteristics. The 3.6 MHz burst is clearly visible on the "A" scope and the moire effect indicates that a substantial portion of the 4.2 MHz signal is passed. However, with the inclusion of extraneous signals, probably carrier leak through that is also evident in the 4.2 MHz waveform monitor multiburst playback picture, see page ~~46~~. 31

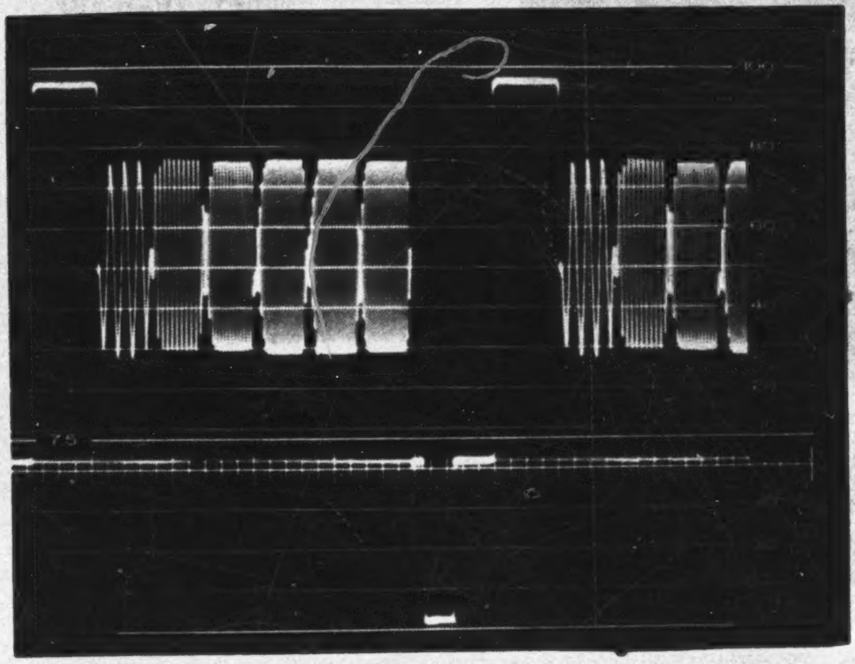
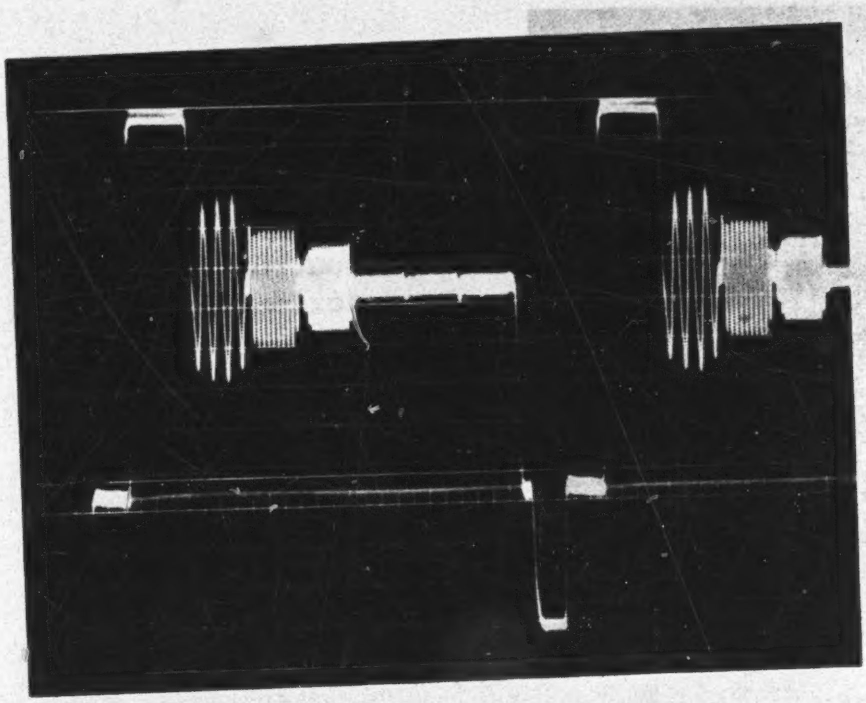
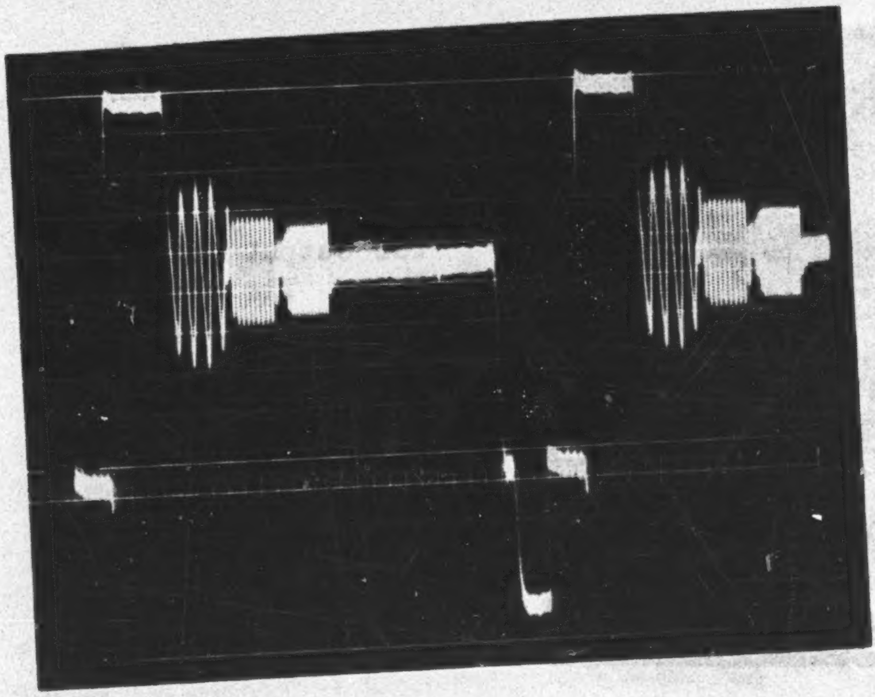


Fig. 3-1 Calibration Multiburst



High frequency roll-off beginning at 1.5 MHz. Level reduced to one-half original level by 2 MHz.

Fig. 3-2 Multiburst Loop-Through



High frequency roll-off beginning at 1.5 MHz. Level reduced to one-half original level by 2 MHz. Slight ringing on the flag and carrier leak through.

Fig. 3-3 Multiburst Playback

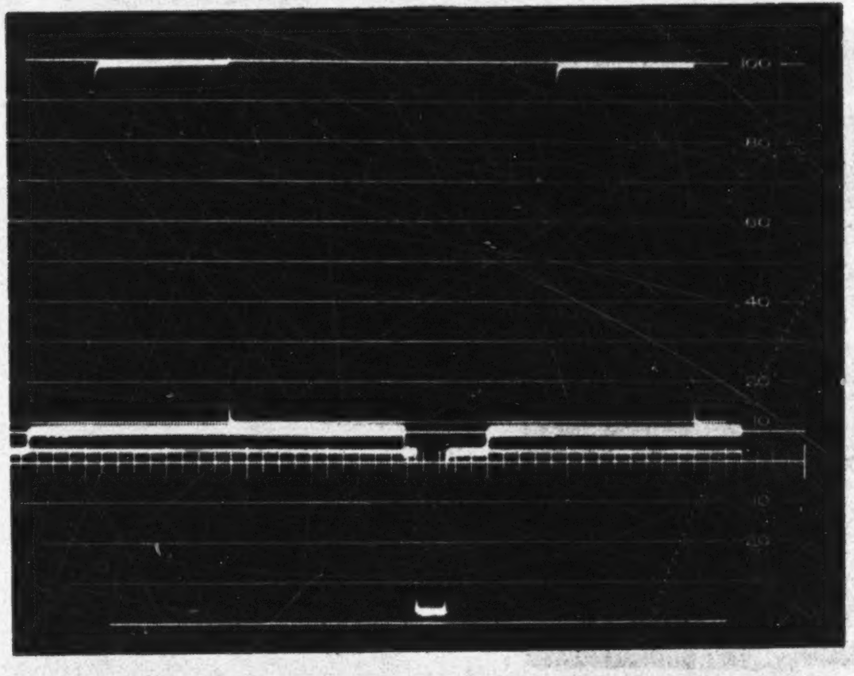
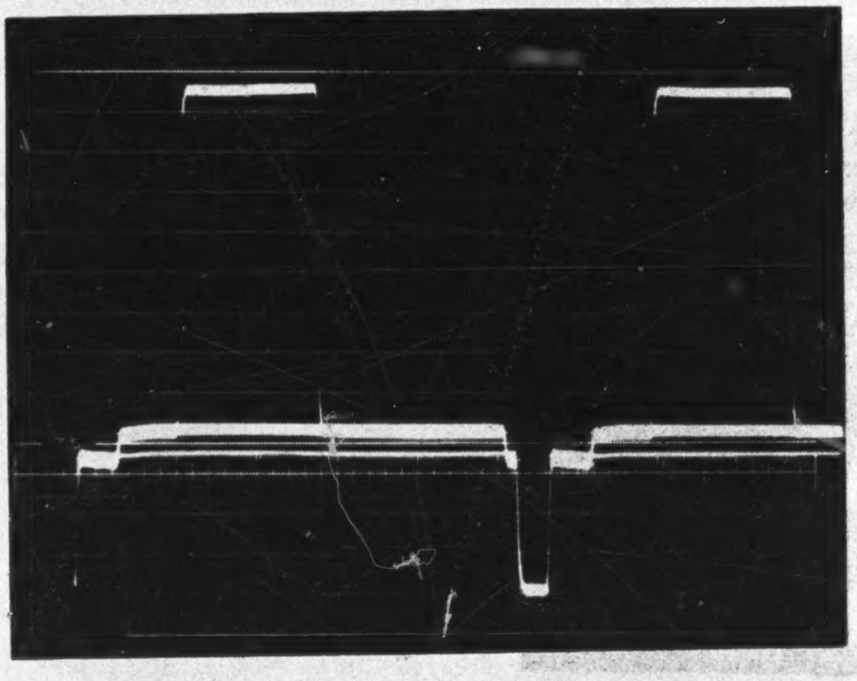
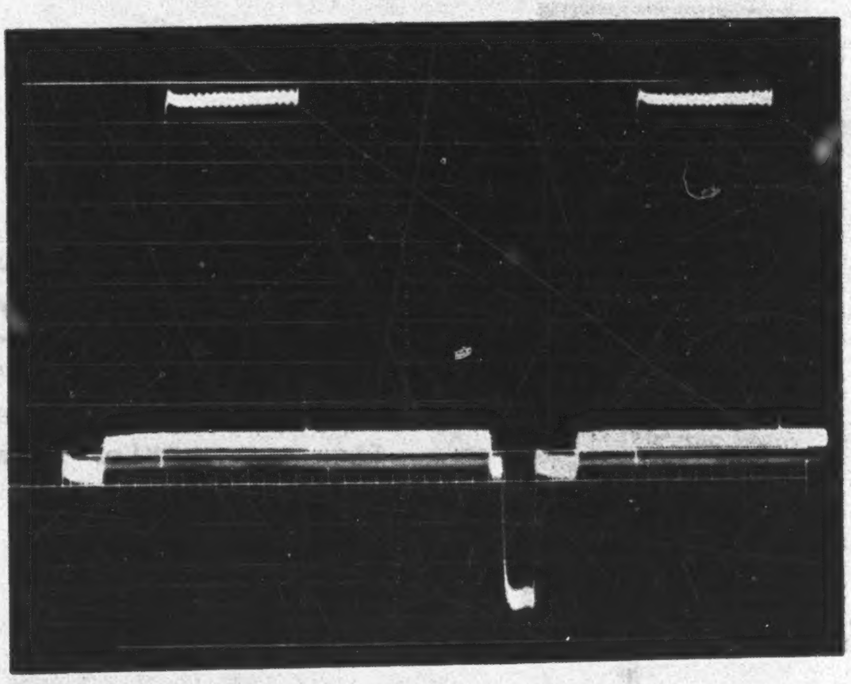


Fig. 3-4 Calibration Window



The output level is approximately 5% down.

Fig. 3-5 Window Loop-Through



The output level is 5% down. The ringing is 3%. Video noise on base line.

Fig. 3-6 Window Playback

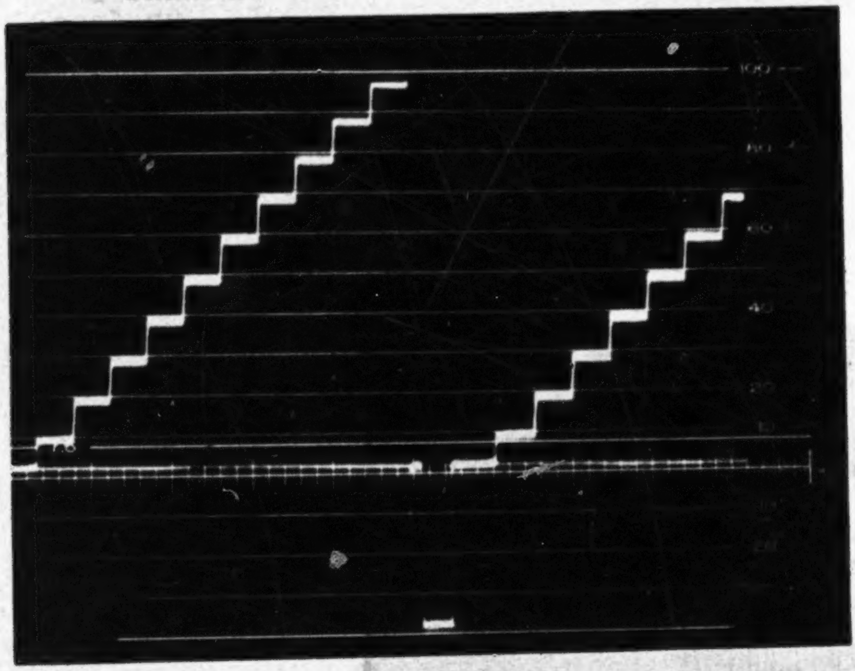
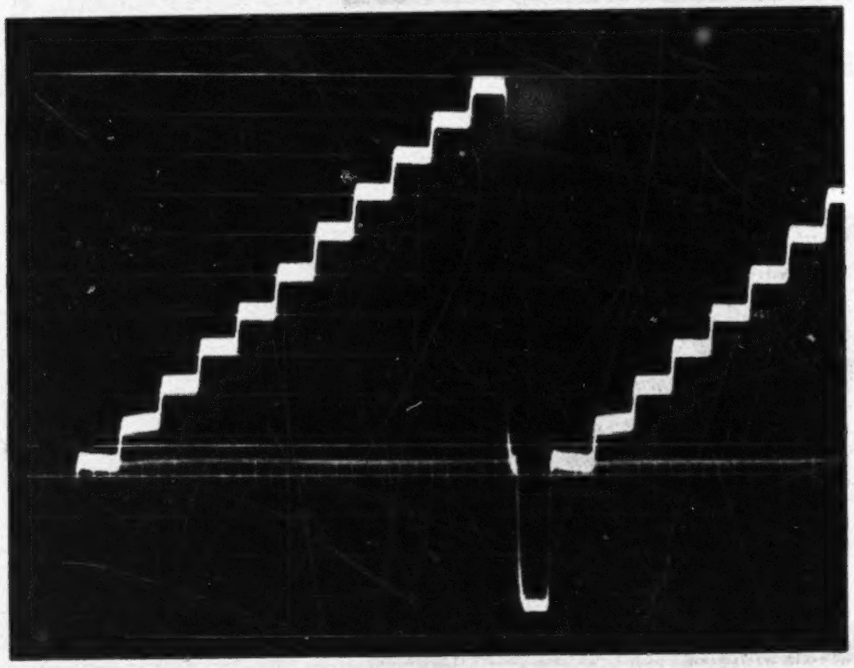
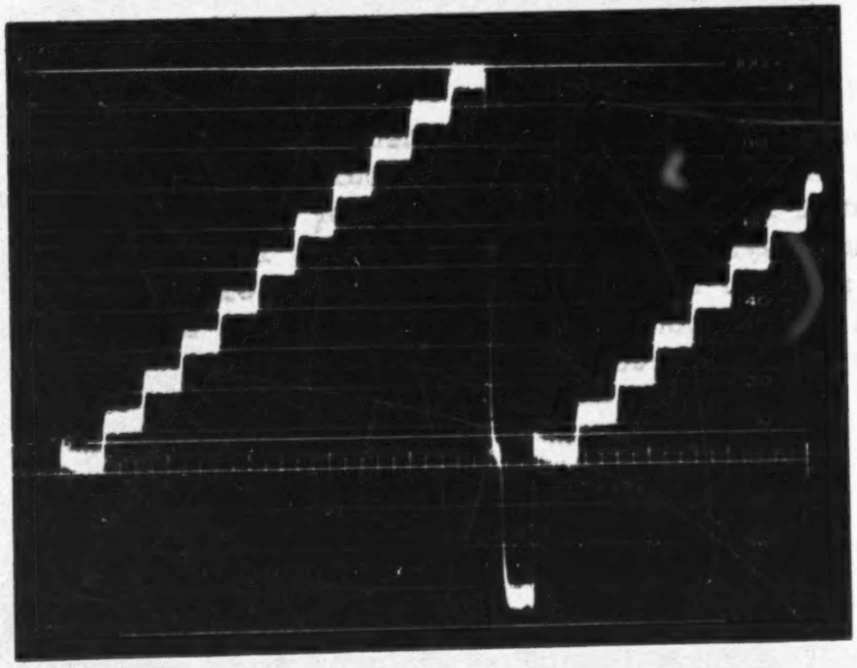


Fig. 3-7 Calibration Stairstep



Video noise or carrier leak through quite noticeable on all steps.

Fig. 3-8 Stairstep Loop-Through



Noise more noticeable than on loop-through and some ringing is noticeable.

Fig. 3-9 Stairstep Playback

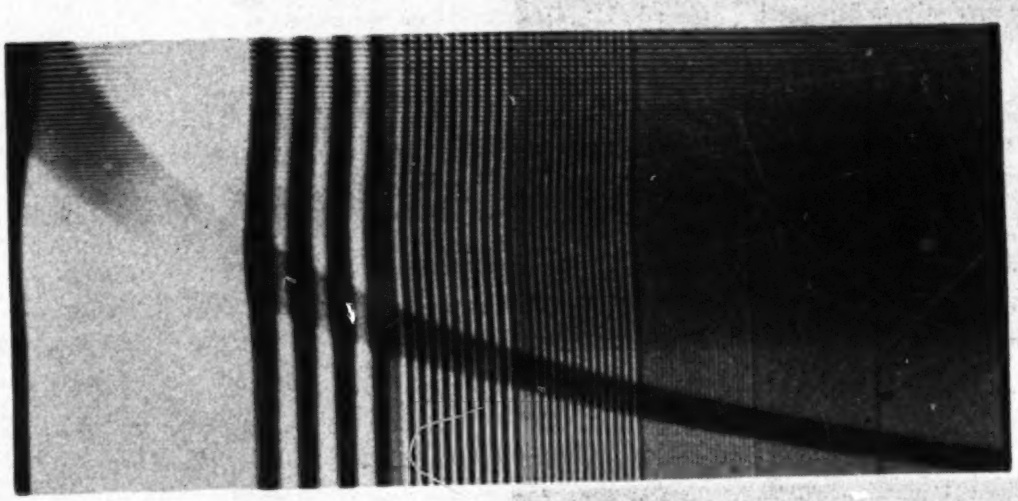


Fig. 3-10 Multiburst "A" Scope Loop-Through

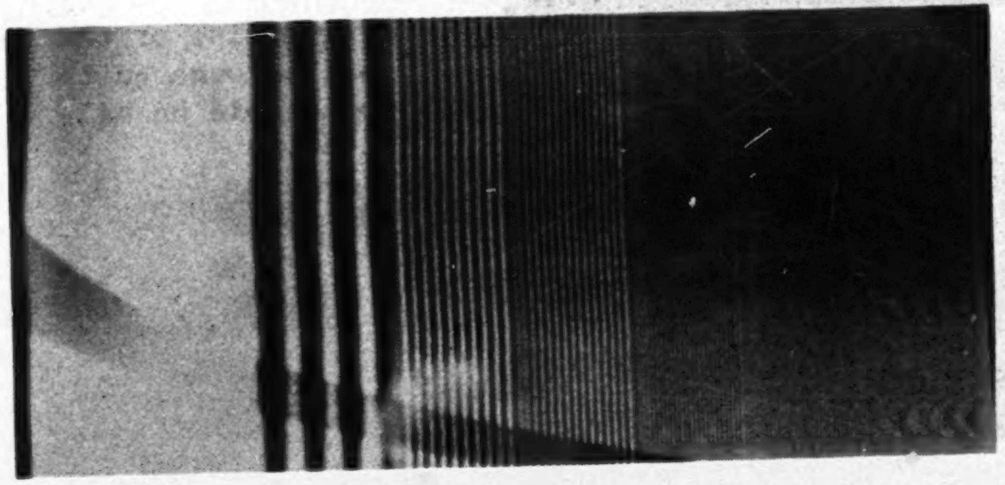


Fig. 3-11 Multiburst "A" Scope Playback

Both loop-through and playback pictures show extraneous signals by the moire patterns. Errors in reproduction of sync pulses cause difficulties in the horizontal intervals near the top of the "A" scope picture. The reproduced sync pulses for successive lines in alternate fields evidently are not uniform as one field is slightly delayed. This is seen as a herringbone effect on the 1.5 MHz and 2.0 MHz bursts near the top of the picture.

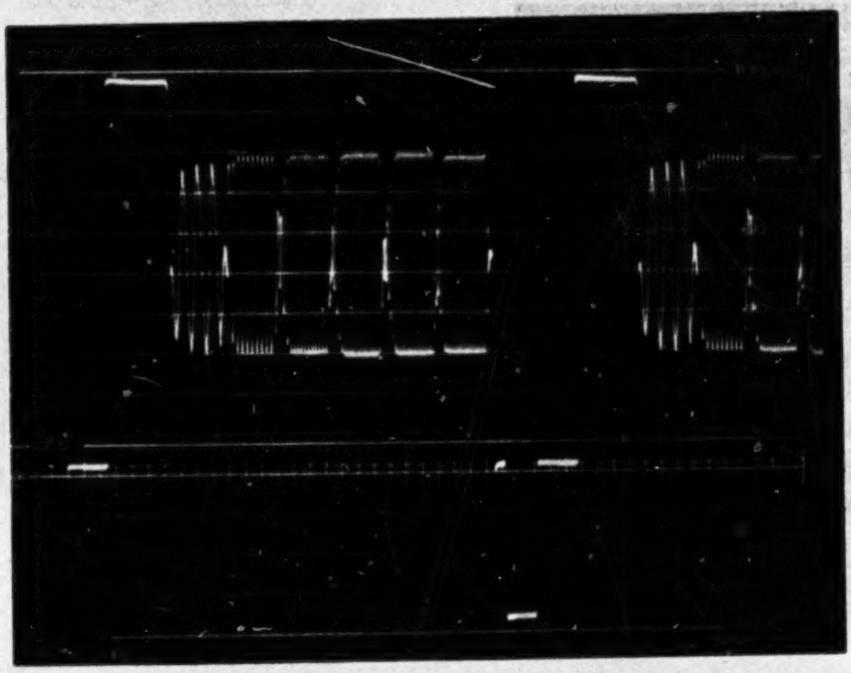
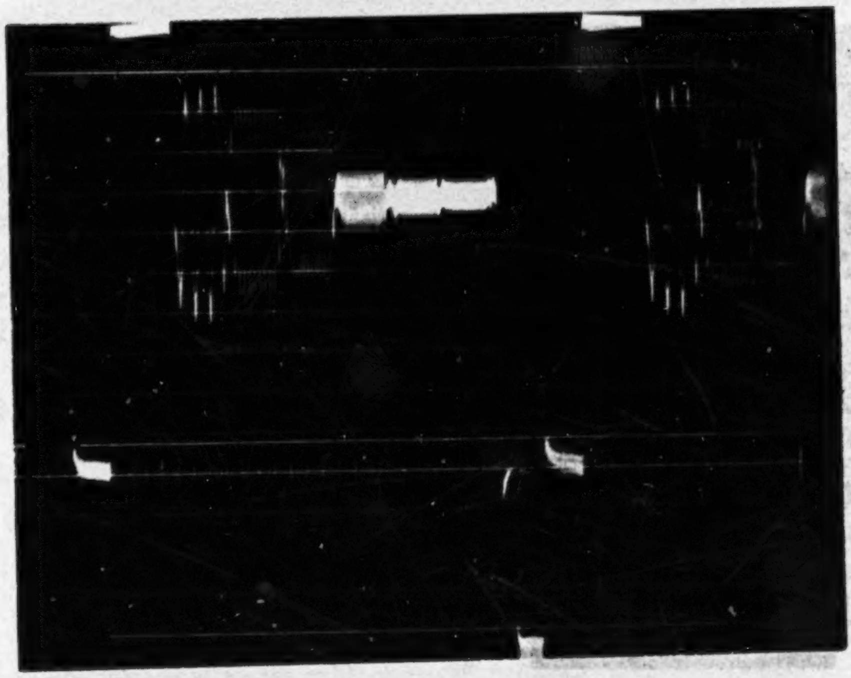
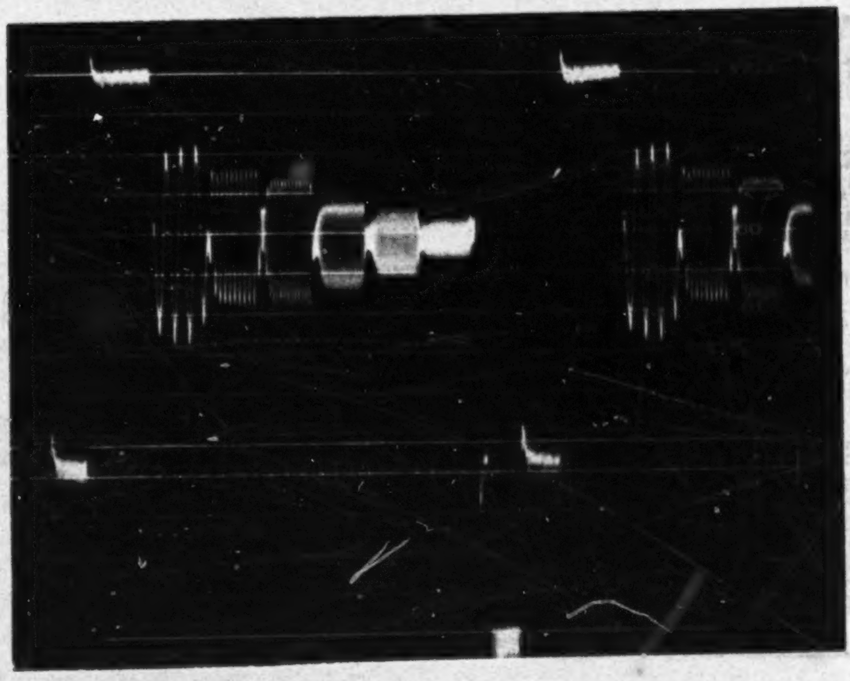


Fig. 4-1 Calibration Multiburst



The output level is approximately 15% high. High frequency roll-off is noticeable at 1.5 MHz. Output level is 30% below normal by 2 MHz and very sharp drop to 60% down at 3.2 MHz. Carrier leak through.

Fig. 4-2 Multiburst Loop-Through



The output level is normal. Noise and ringing on flag. Roll-off beginning at 1.5 MHz. Level is 30% down at 2 MHz and 50% down at 3.2 MHz. Roll-off less sharp than in loop-through.

Fig. 4-3 Multiburst Playback

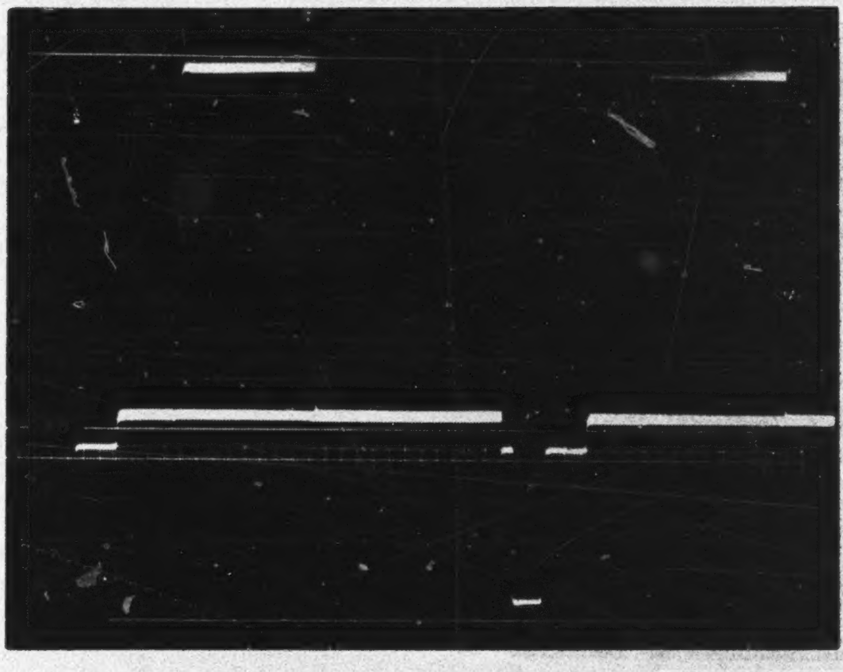
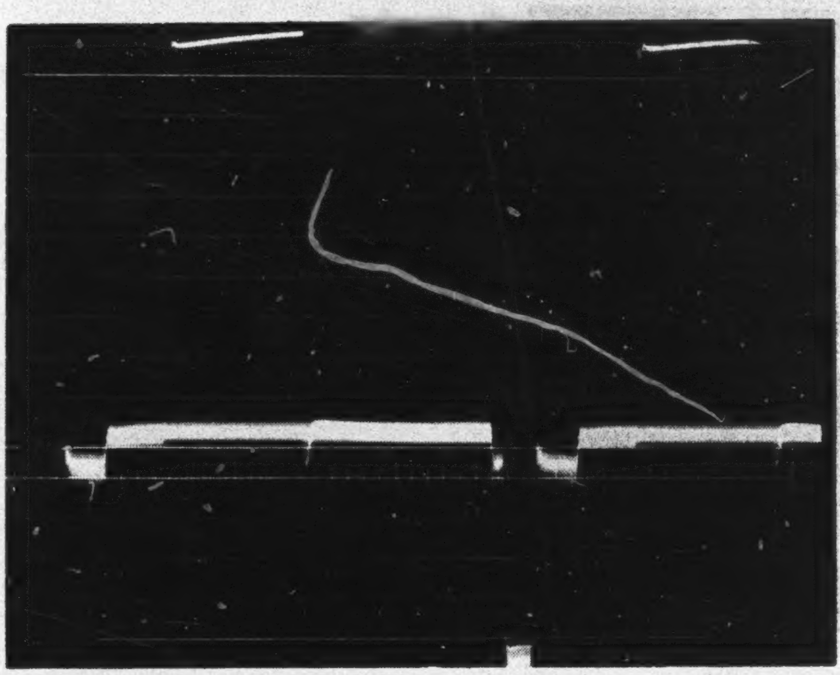
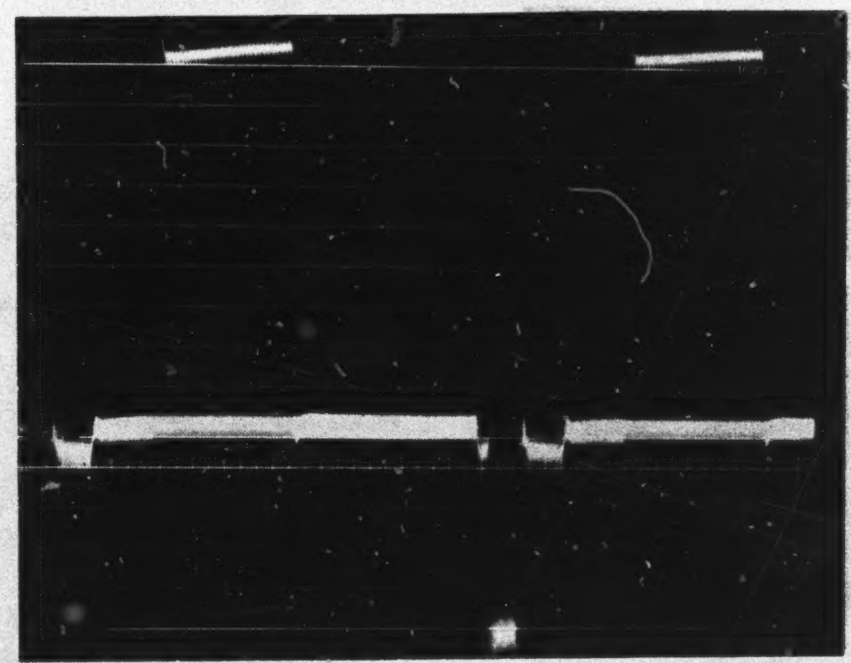


Fig. 4-4 Calibration Window



Definite tilt on window indicating accentuated low frequency response. Base line noise indicates carrier leak through. The output level is 10% high.

Fig. 4-5 Window Loop-Through



The tilt on window indicated accentuated low frequency response. Approximately 3% ringing. Carrier leak through and noise noticeable on base line. The output level is approximately 5% high.

Fig. 4-6 Window Playback

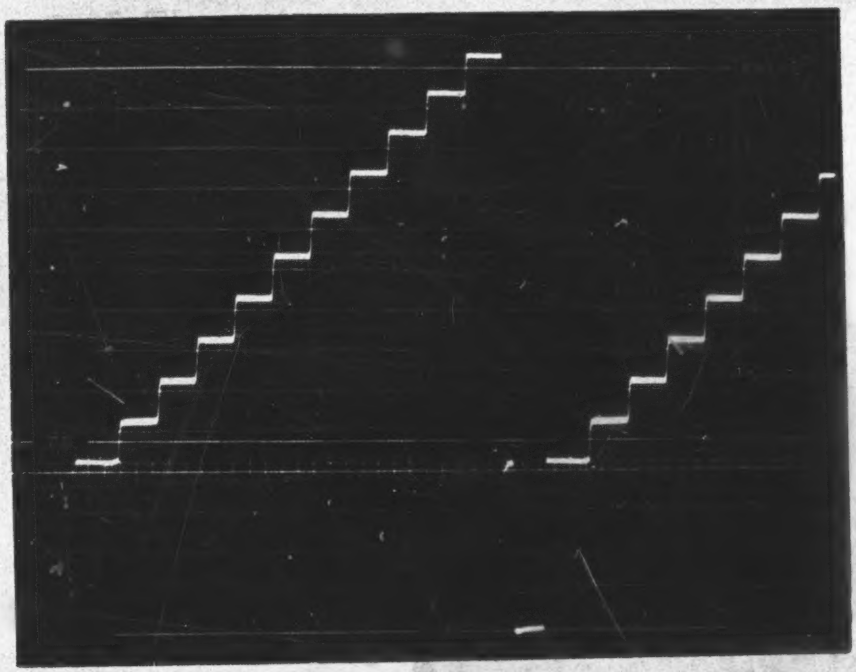


Fig. 4-7 Calibration Stairstep

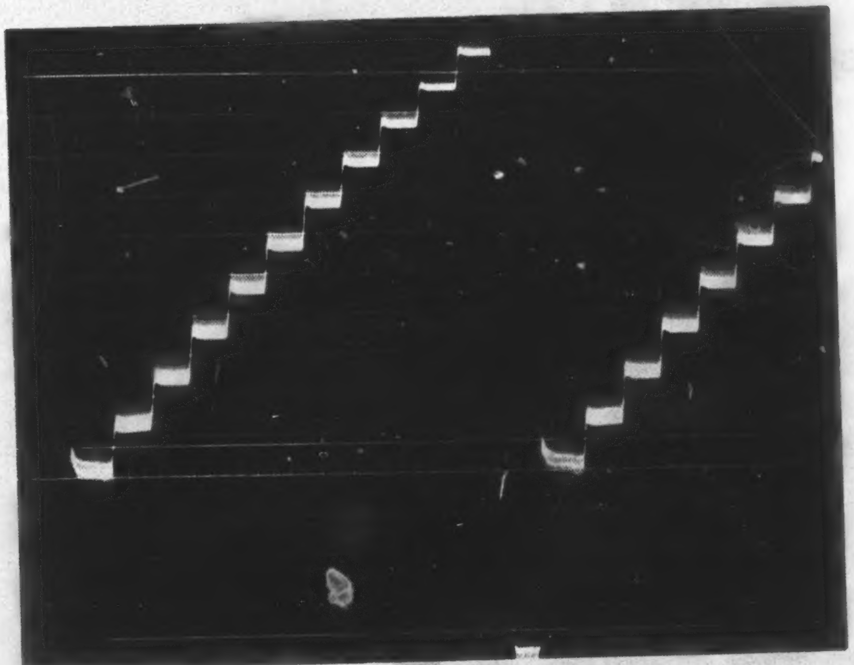


Fig. 4-8 Stairstep Loop-Through

Carrier leak through noticeable on all steps. Slight ringing noticeable on all steps. Slight differential gain distortion but not in excess of 3%.

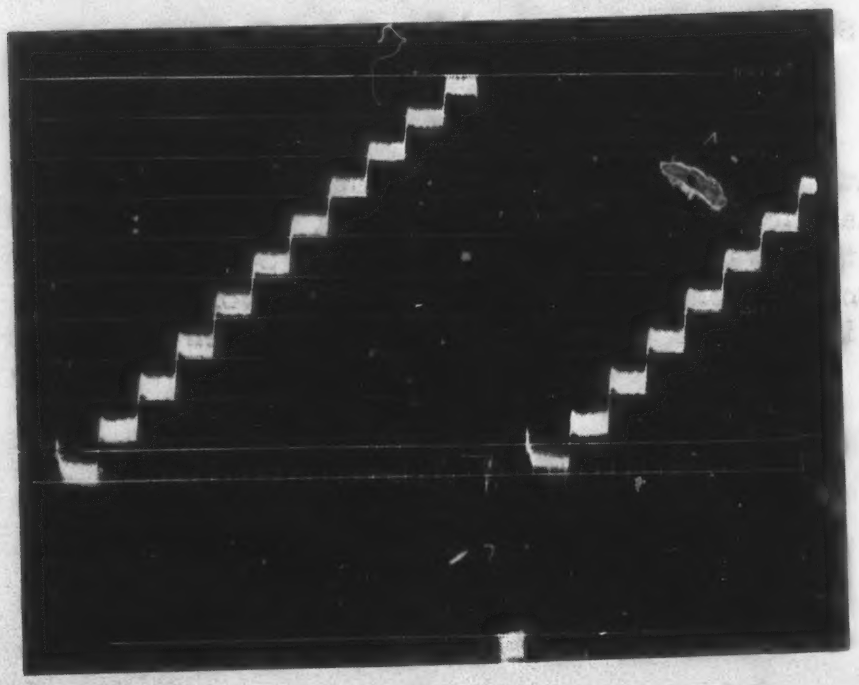


Fig. 4-9 Stairstep Playback

The output level is approximately 5% low. Noticeable ringing on all steps. Noise, carrier leak through, and differential gain are the same a
in loop-through.

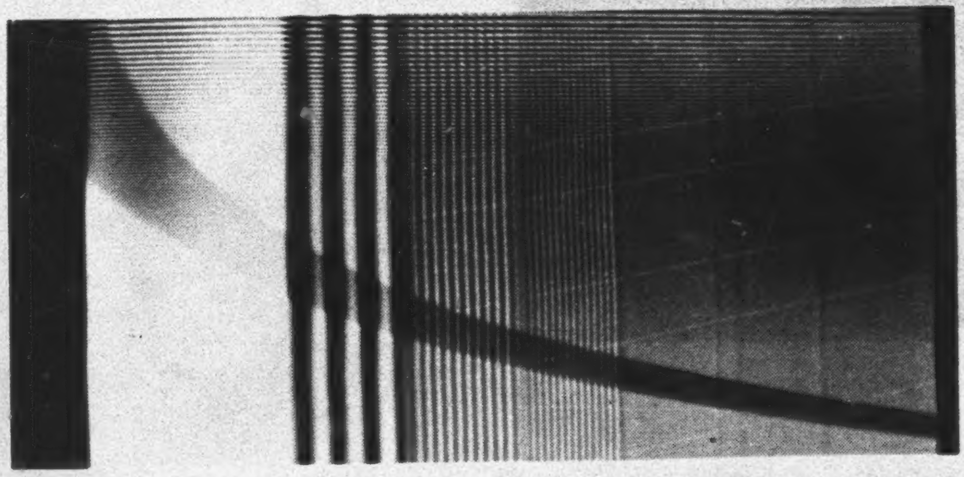


Fig. 4-10 Multiburst "A" Scope Loop-Through

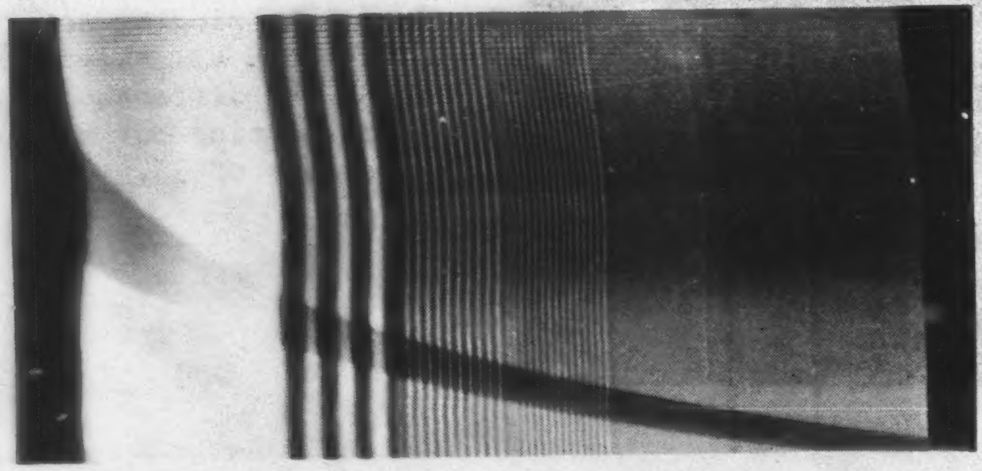


Fig. 4-11 Multiburst "A" Scope Playback

The sync pulses on alternate fields are delayed in both the loop-through signals and the playback near the top of the "A" scope picture. The playback picture was adjusted for minimum "S" distortion by means of the tension control. This type of distortion is still evident. Detail in the 3.2 MHz burst is almost absent.

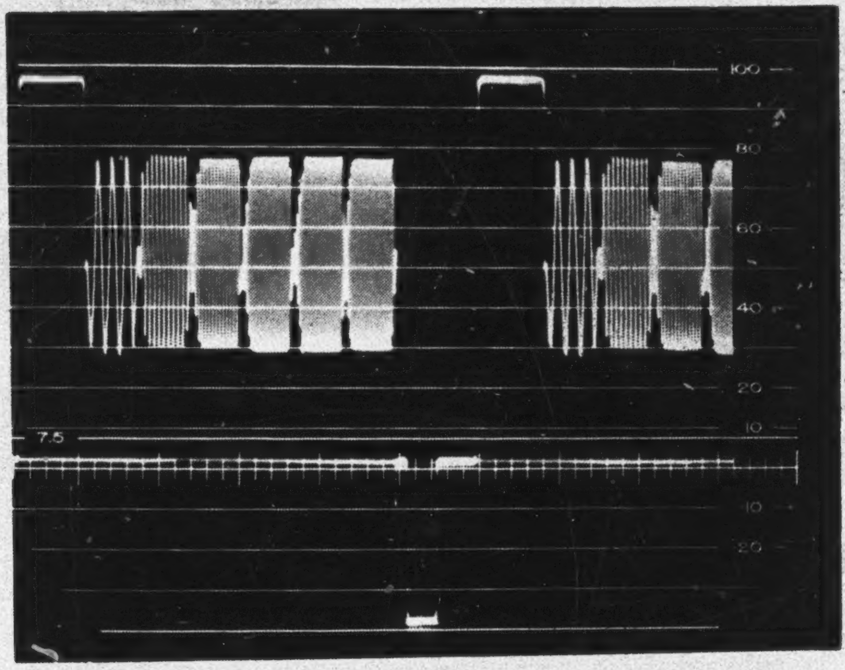


Fig. 5-1 Calibration Multiburst

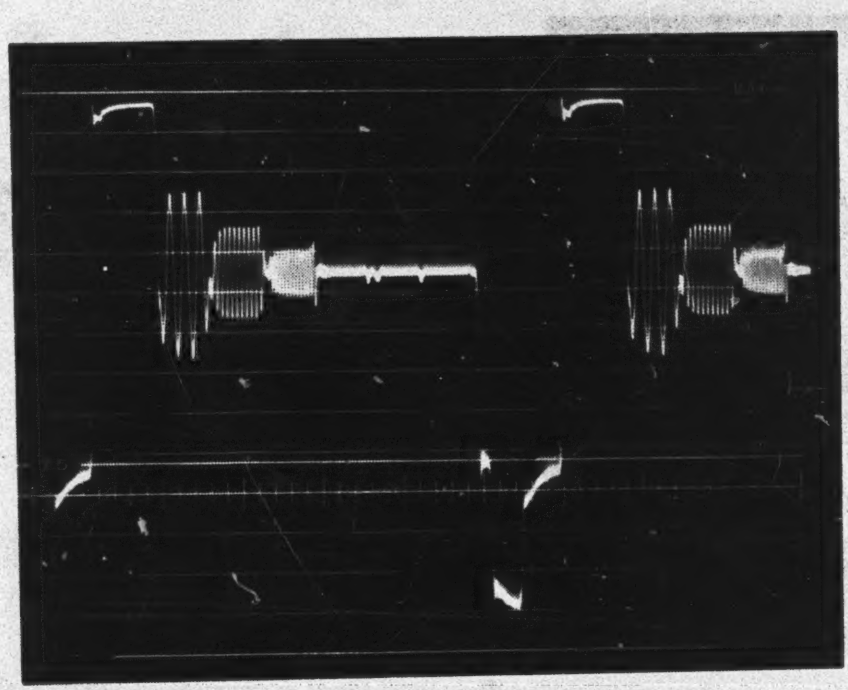


Fig. 5-2 Multiburst Loop-Through

The output level is normal. The burst signal is 30% down at 0.5 MHz and 50% down at 1.5 MHz. No burst signal is visible from 3.2 MHz on. Ringing on leading edge of flag burst.

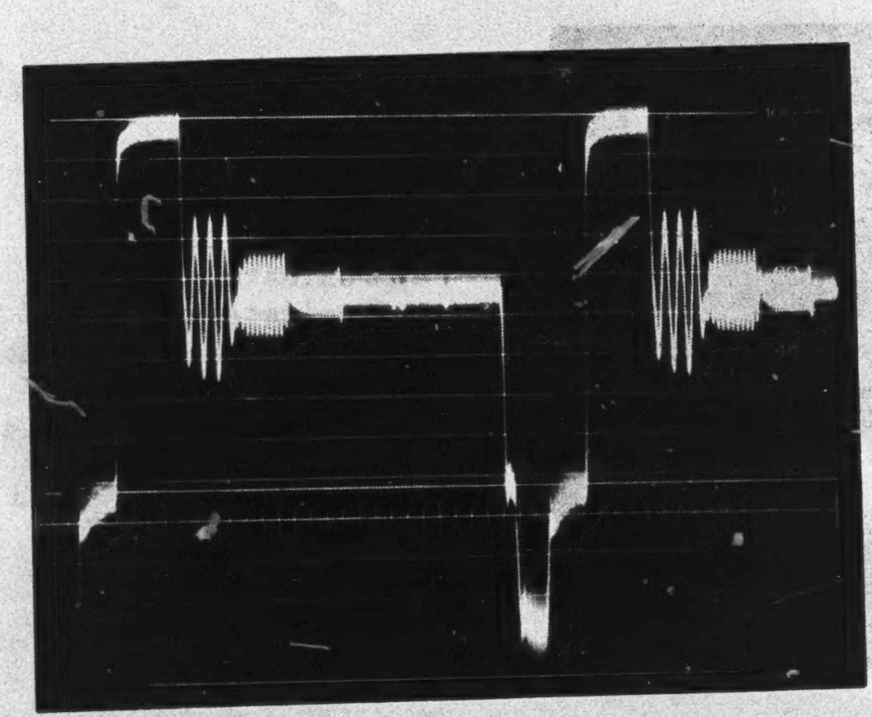


Fig. 5-3 Multiburst Playback

The output level is normal. The burst signal is 30% down at 0.5 MHz and 50% down at 1.5 MHz. No burst signal is visible from 3.2 MHz on. Ringing on leading edge of flag burst. Approximately 5% noise and carrier leak through.

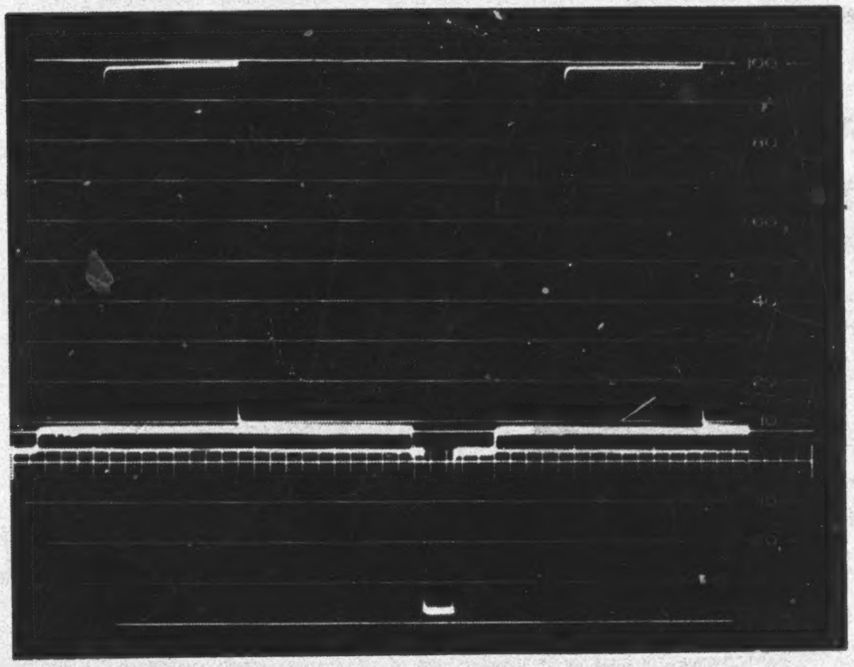


Fig. 5-4 Calibration Window

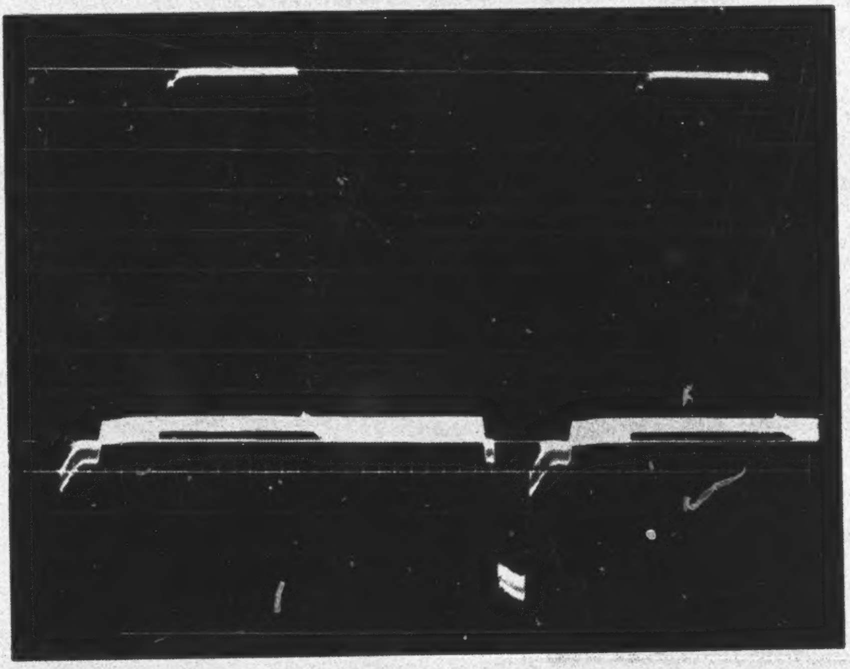


Fig. 5-5 Window Loop-Through

Ringing on leading edge of window. Carrier leak through on base line.

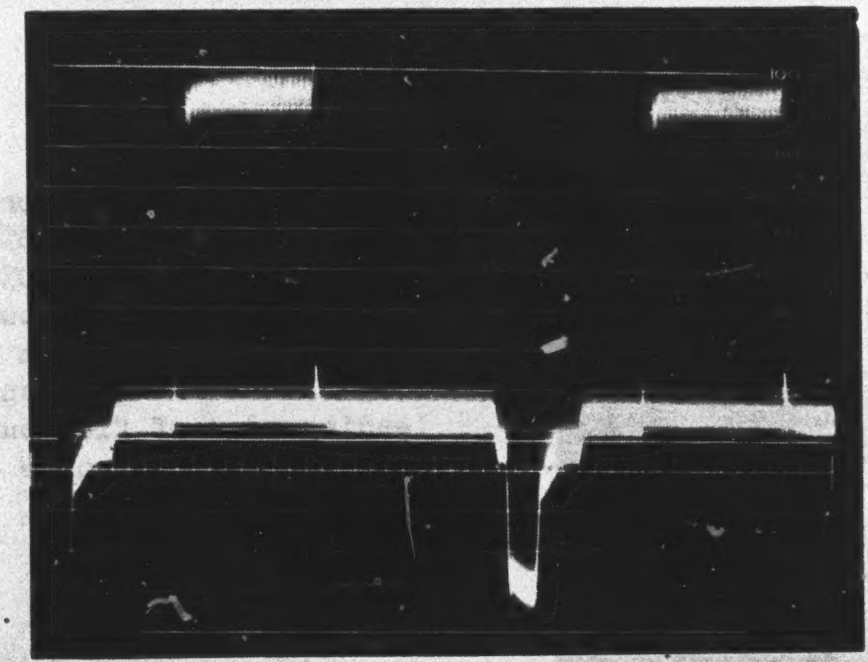


Fig. 5-6 Window Playback

The output level is approximately 7% low. Approximately 3% to 4% ringing on entire window. 10% noise and carrier leak through on base line.

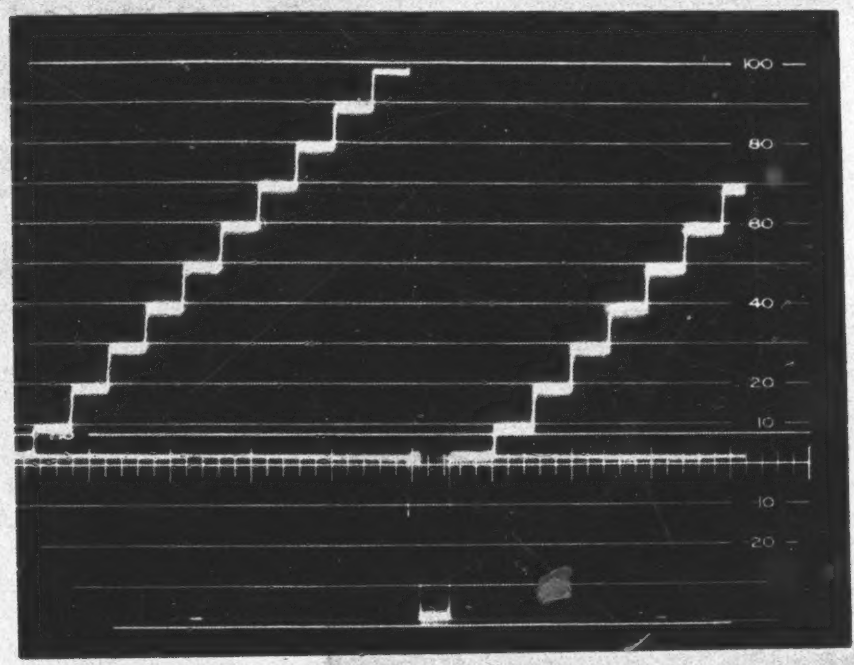
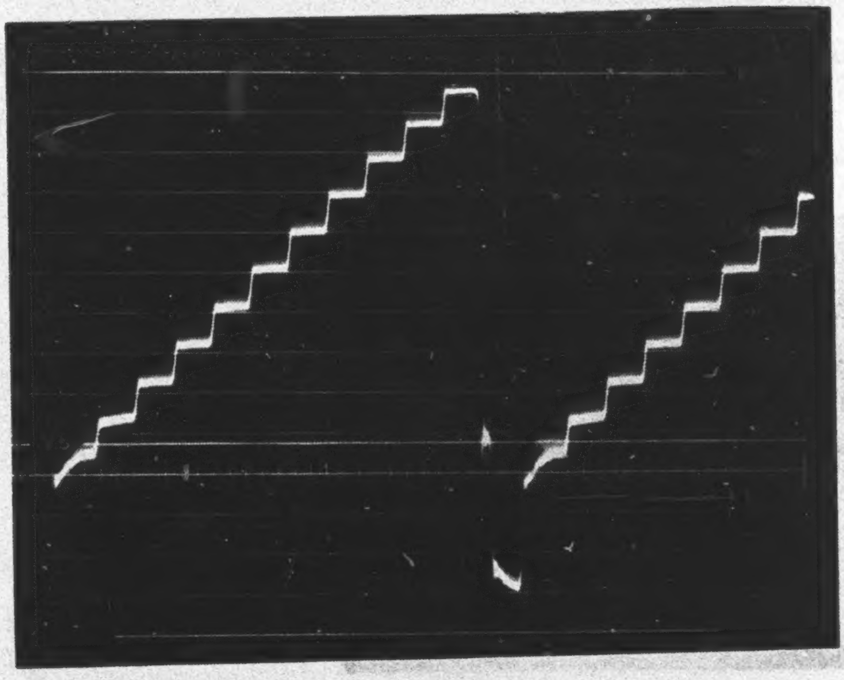
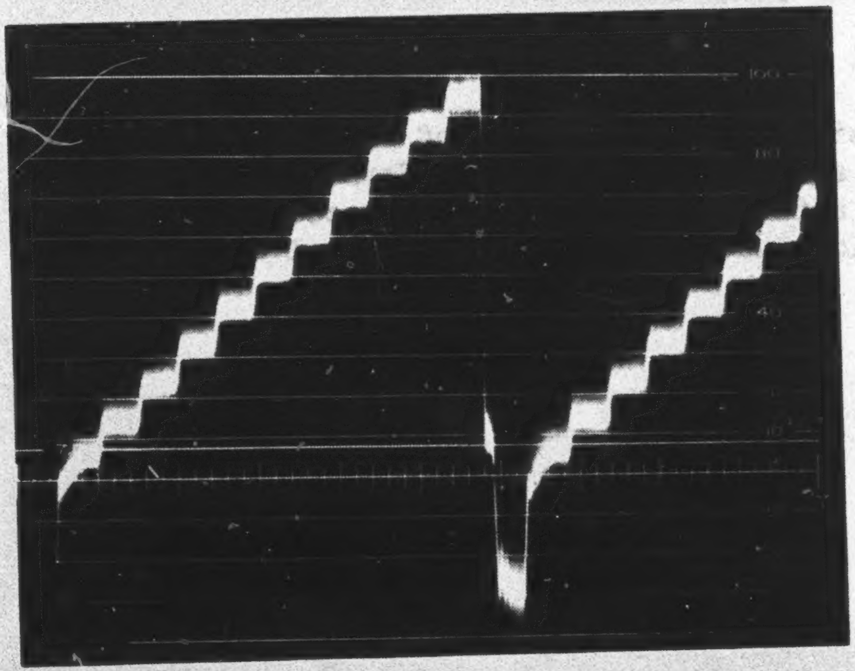


Fig. 5-7 Calibration Stairstep



The output level is 2% low. Differential gain good. Mild carrier leak through on all steps.

Fig. 5-8 Stairstep Loop-Through



The output level is 5% low. Noise, carrier leak through, and ringing adding to 10% visible on all steps.

Fig. 5-9 Stairstep Playback

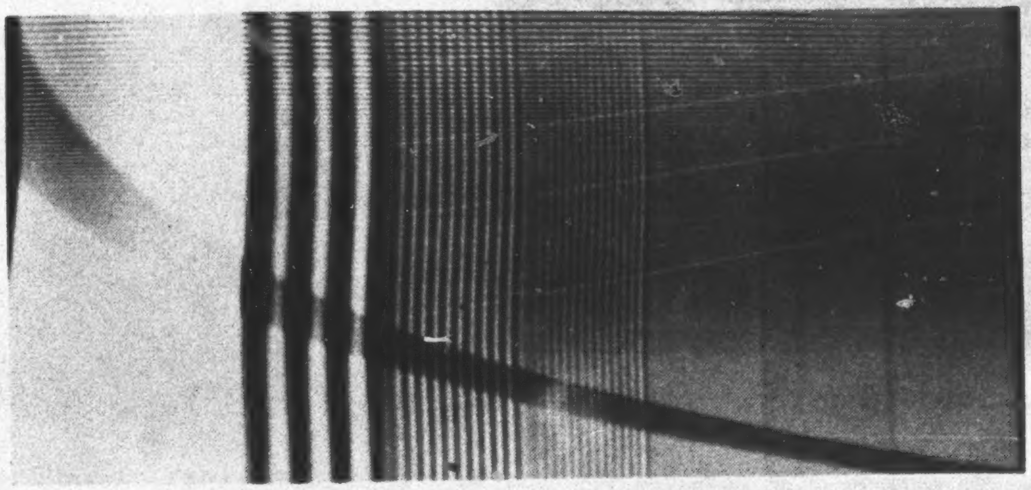


Fig. 5-10 Multiburst "A" Scope Loop-Through

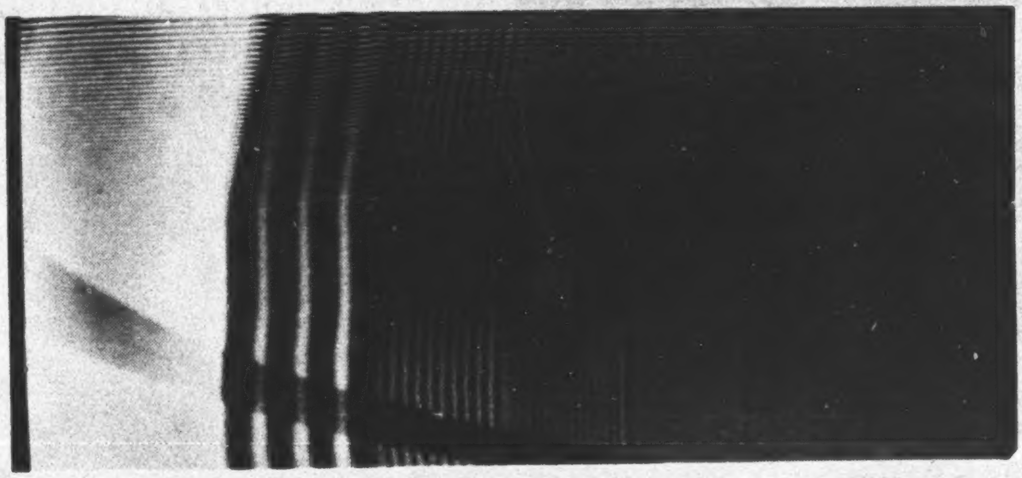


Fig. 5-11 Multiburst "A" Scope Playback

No "A" scope detail is visible in the playback of the 3.2 MHz burst. The reproduced horizontal sync pulses are not uniform from top to bottom of the picture and alternate fields are displaced a noticeable degree. "S" distortion due to insufficient control over the tape tension is evident.

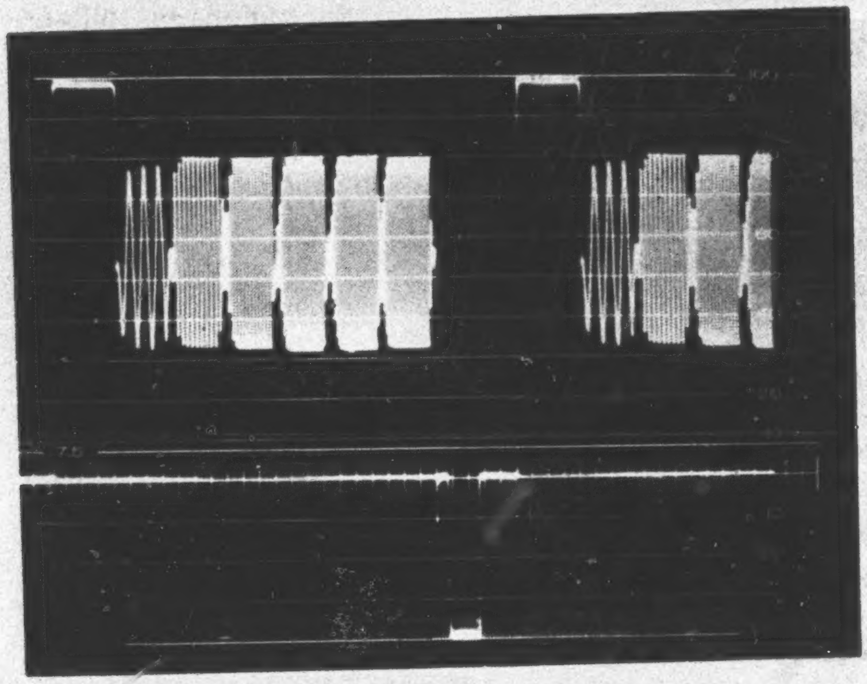
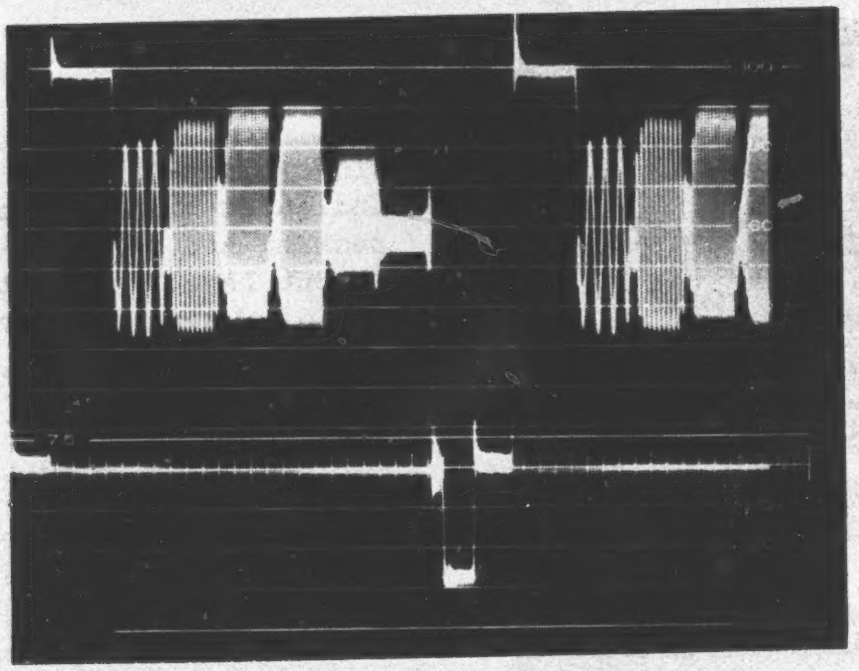
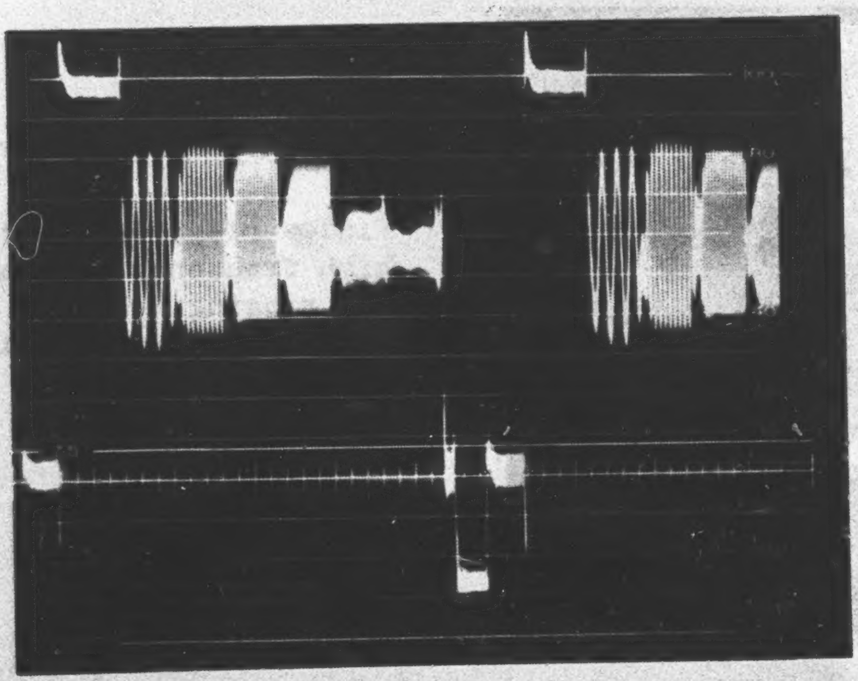


Fig. 6-1 Calibration Multiburst



Flag indicates high frequency peaking and ringing. Irregular placement of multiburst signals indicates modulation or demodulation system distortion.

Fig. 6-2 Multiburst Loop-Through



Flag burst indicates high frequency peaking and slight ringing. Irregular placement of multiburst signals less pronounced. High frequency response approximately 35% down at 3.2 MHz. Over 50% down at 3.6 MHz. About 7% noise in carrier leak through.

Fig. 6-3 Multiburst Playback

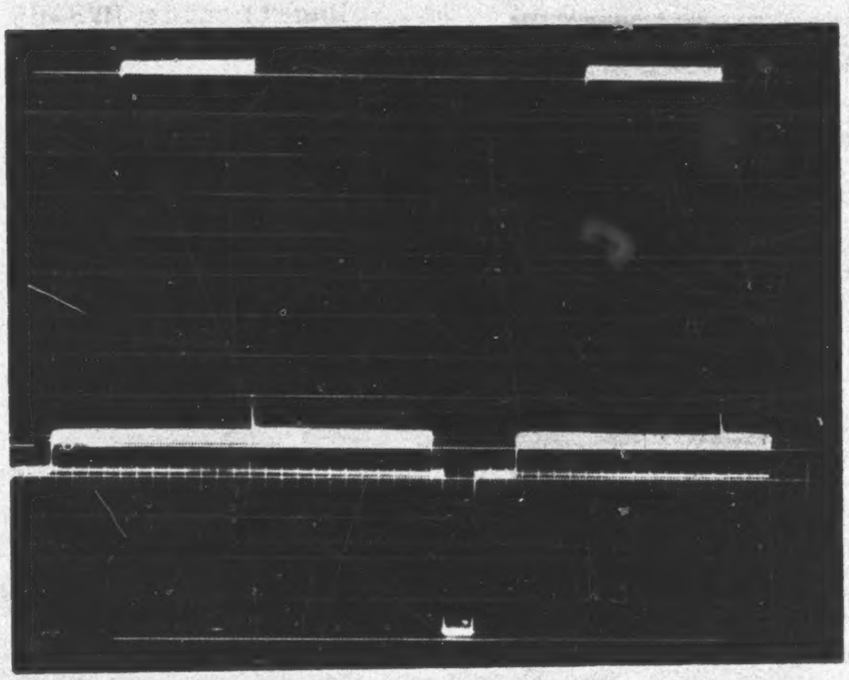
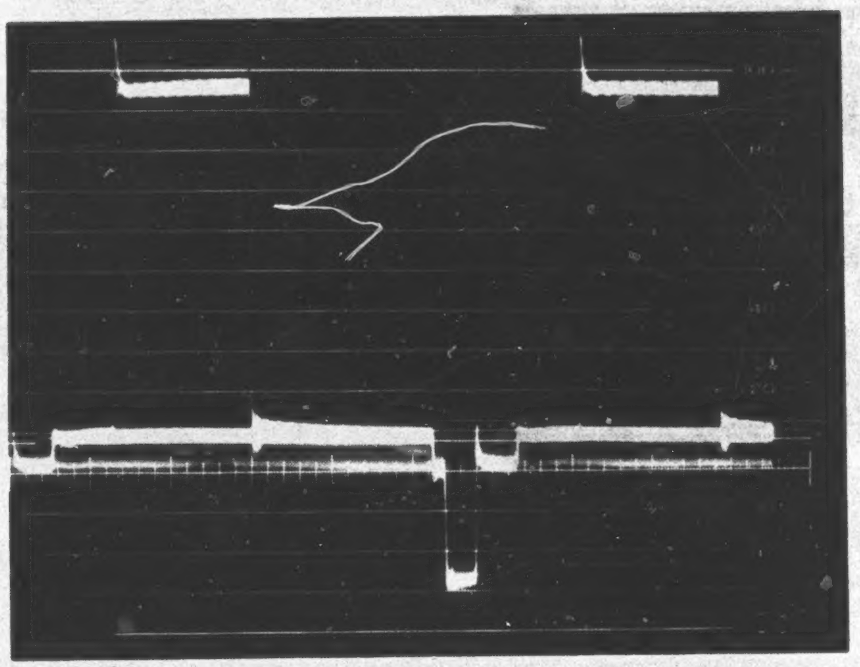
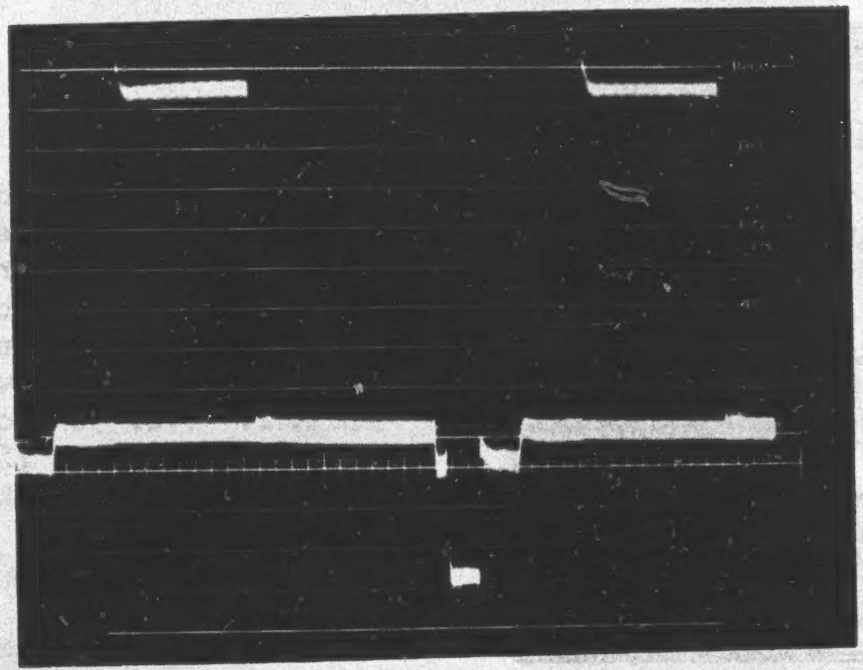


Fig. 6-4 Calibration Window



Window loop-through indicates high frequency peaking and ringing. Output level is about 5% low with some carrier leak through.

Fig. 6-5 Window Loop-Through



Window playback indicates high frequency peaking and ringing. Output level is about 5% low and about 3% noise and carrier leak through.

Fig. 6-6 Window Playback

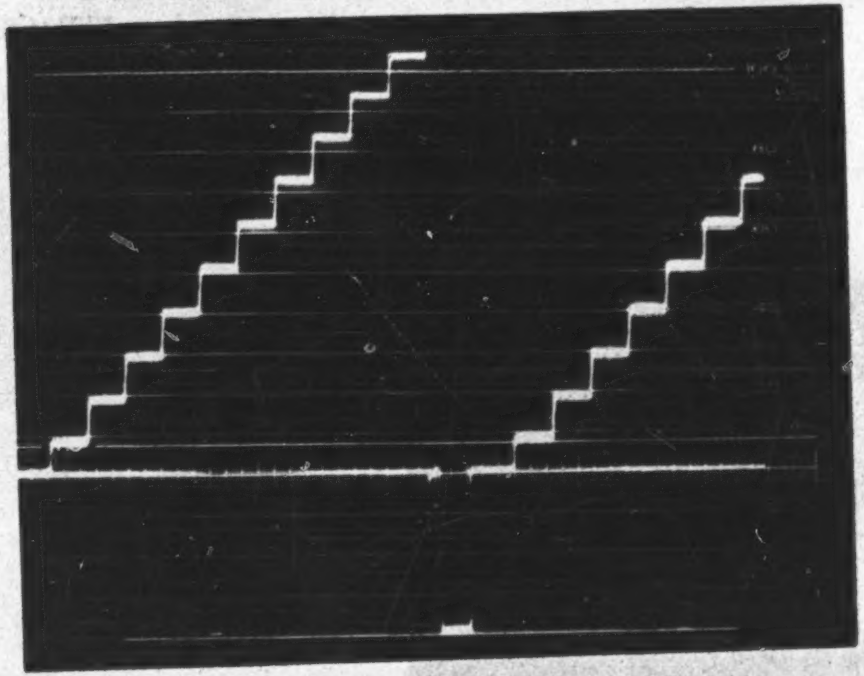


Fig. 6-7 Calibration Stairstep

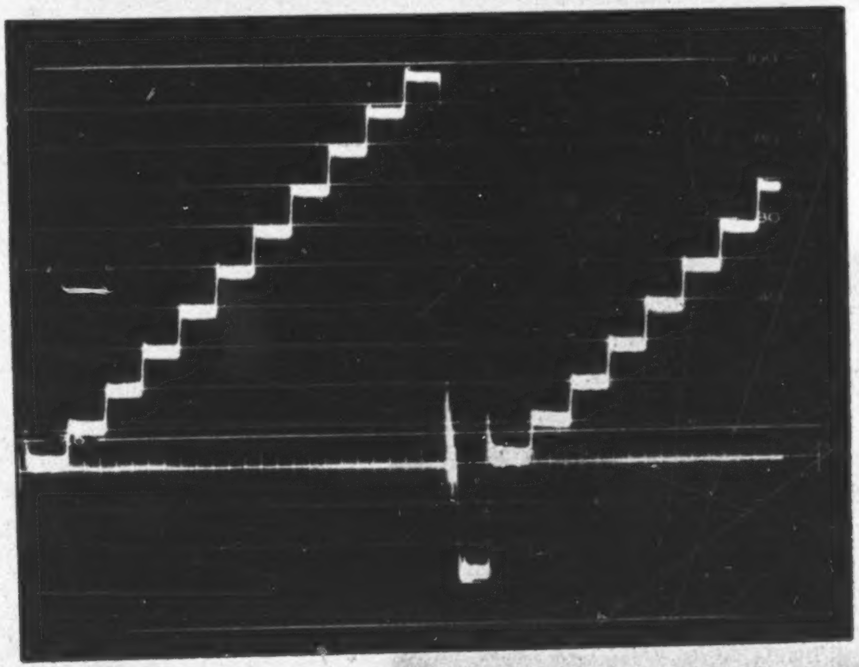


Fig. 6-8 Stairstep Loop-Through

Differential gain is very good. High frequency peaking noted on each step. Approximately 1-1/2% carrier leak through.

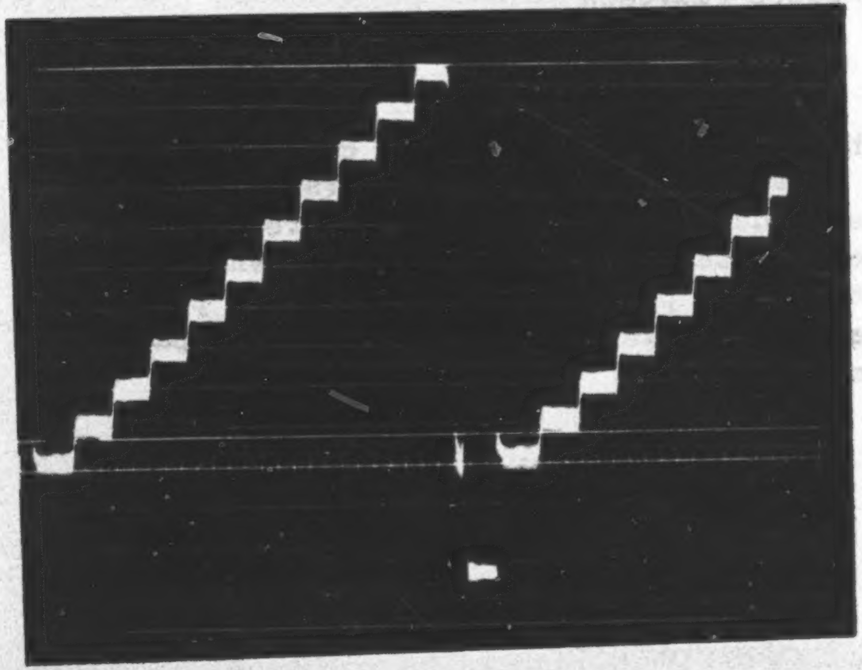


Fig. 6-9 Stairstep Playback

Some high frequency peaking on each step. Differential gain very good. About 4% noise and carrier leak through.

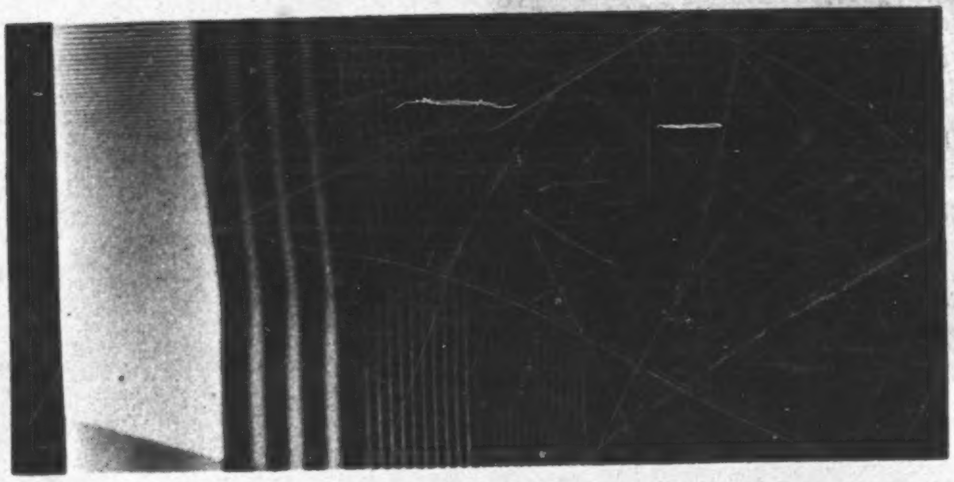


Fig. 6-10 Multiburst "A" Scope Loop-Through

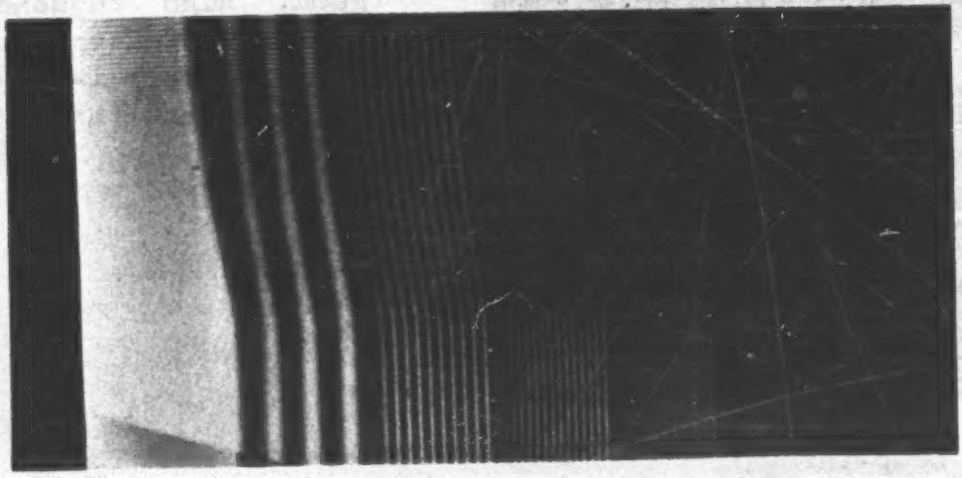


Fig. 6-11 Multiburst "A" Scope Playback

This video tape recorder has excellent reproduction capabilities through 3.2 MHz with fair detail up to the 3.6 MHz burst. Some leakage carrier or other spurious signals cause the moire pattern in the 3.6 MHz burst. The tape tension control must be readjusted to eliminate the skew of the upper portion of the "A" scope picture. The bottom portion shows excellent linearity and shows the capability of the properly adjusted machine.

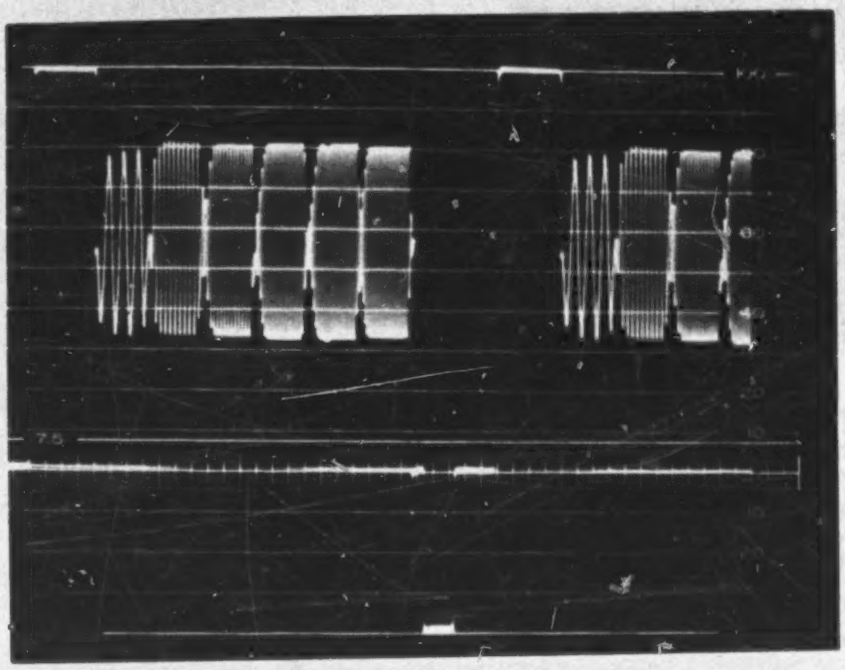
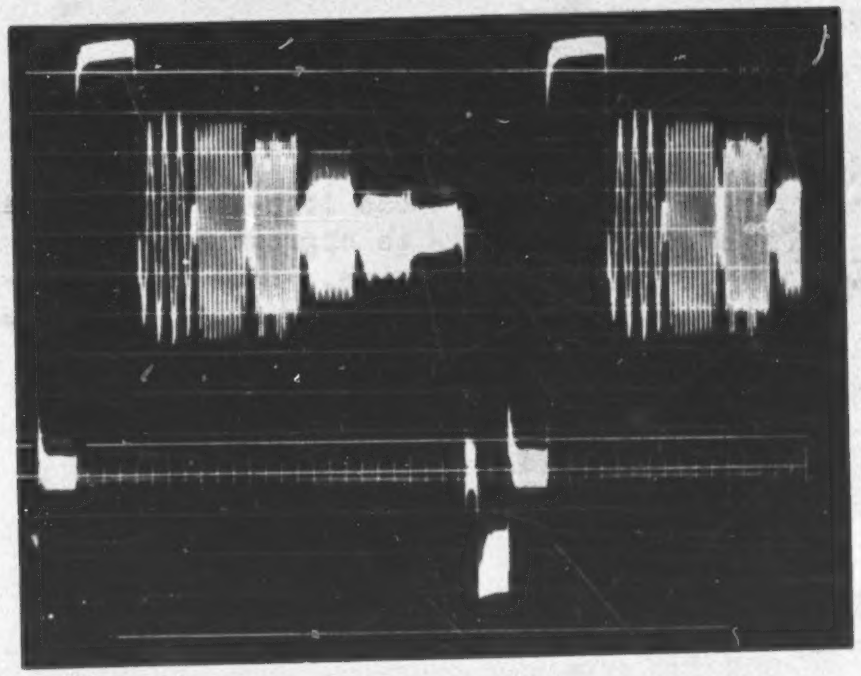
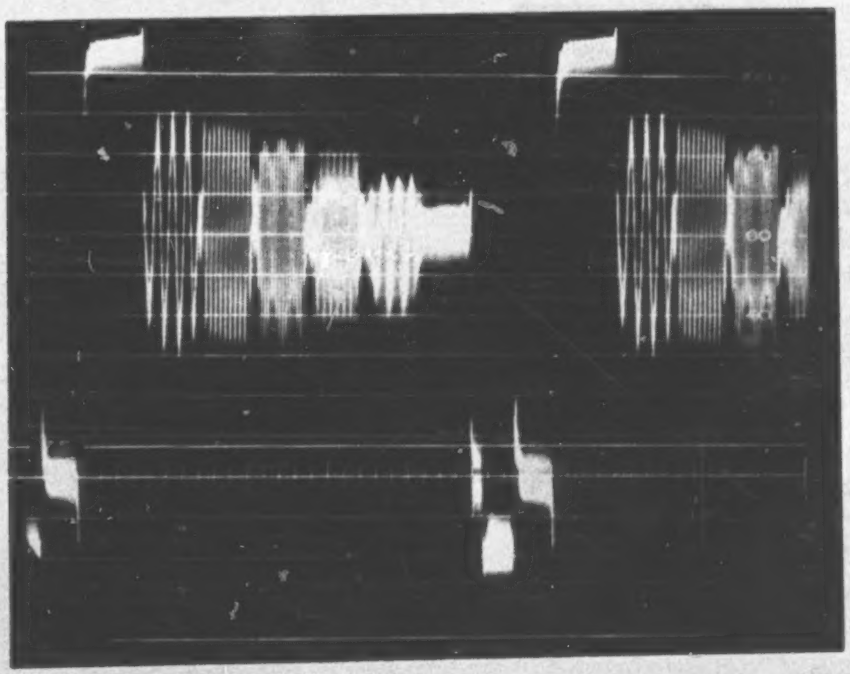


Fig. 7-1 Calibration Multiburst



Flag indicates high frequency roll-off and slight ringing. Multiburst signals indicate bad interference between video information and carrier frequency. Frequency response down to approximately 40% at 3.2 MHz. Extreme carrier leak through. Video level 10% high. Sync level 15% short.

Fig. 7-2 Multiburst Loop-Through



Video level about 7% high. Sync level 20% low. Distortion in multiburst signal due to interference between video information and carrier frequency which would cause moire interference in picture. Response down to approximately 40% at 3.2 MHz. Noise and carrier leak through approximately 9%.

Fig. 7-3 Multiburst Playback

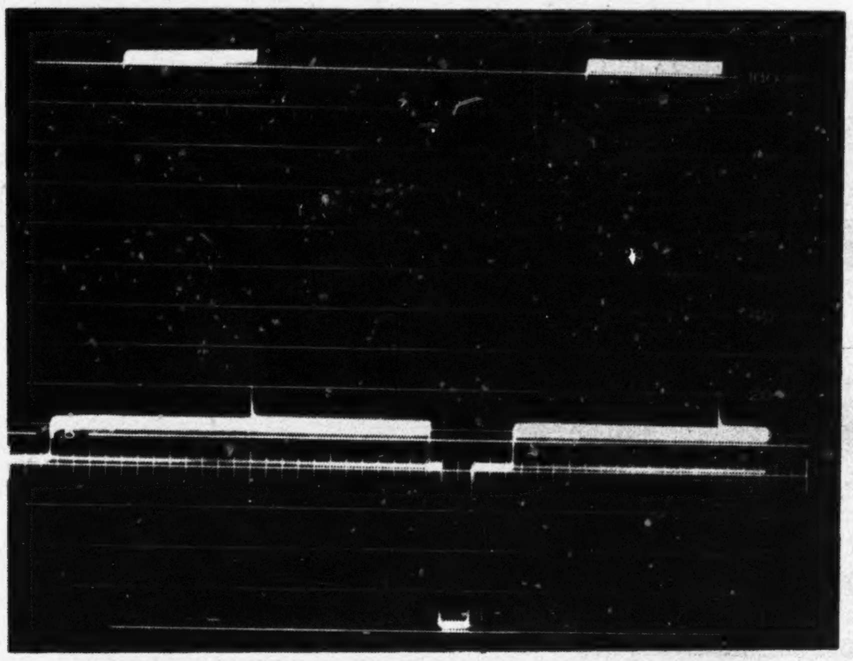
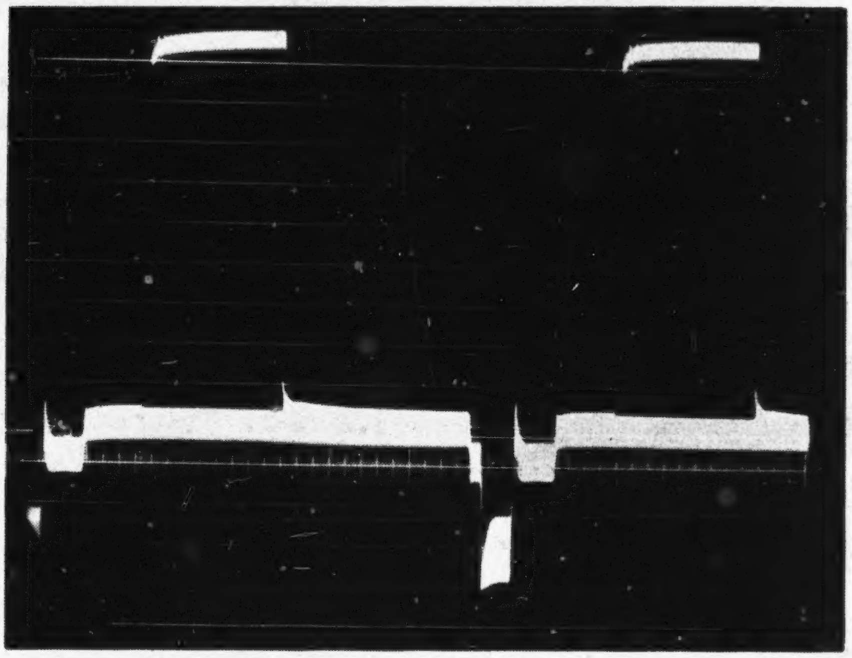
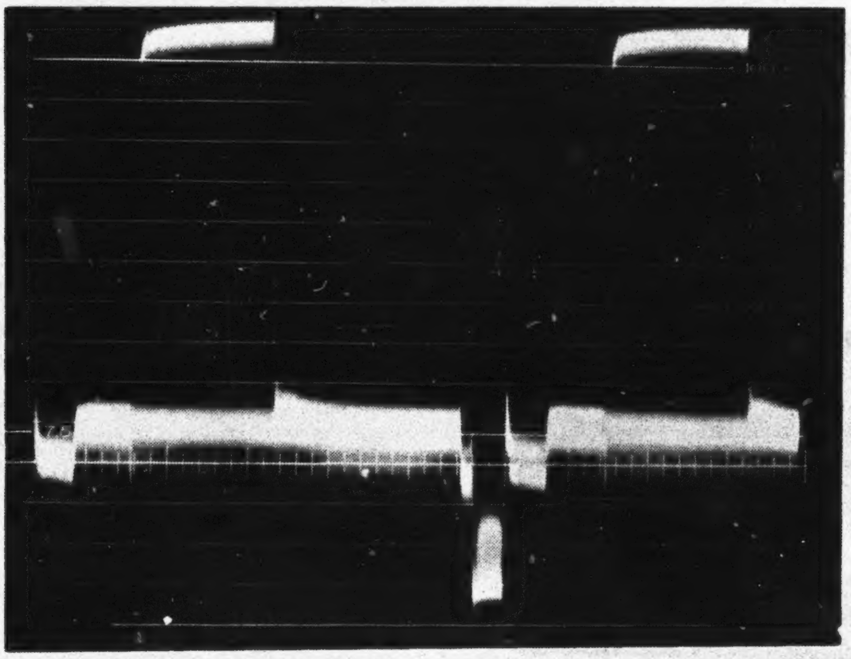


Fig. 7-4 Calibration Window



The loop-through signal is approximately 6% high. Some high frequency ringing indicated. Carrier leak through extremely bad. Sync level 15% low.

Fig. 7-5 Window Loop-Through



Playback video level is 7% to 8% high. Noise and carrier leak through extremely bad. Sync level down 15%.

Fig. 7-6 Window Playback

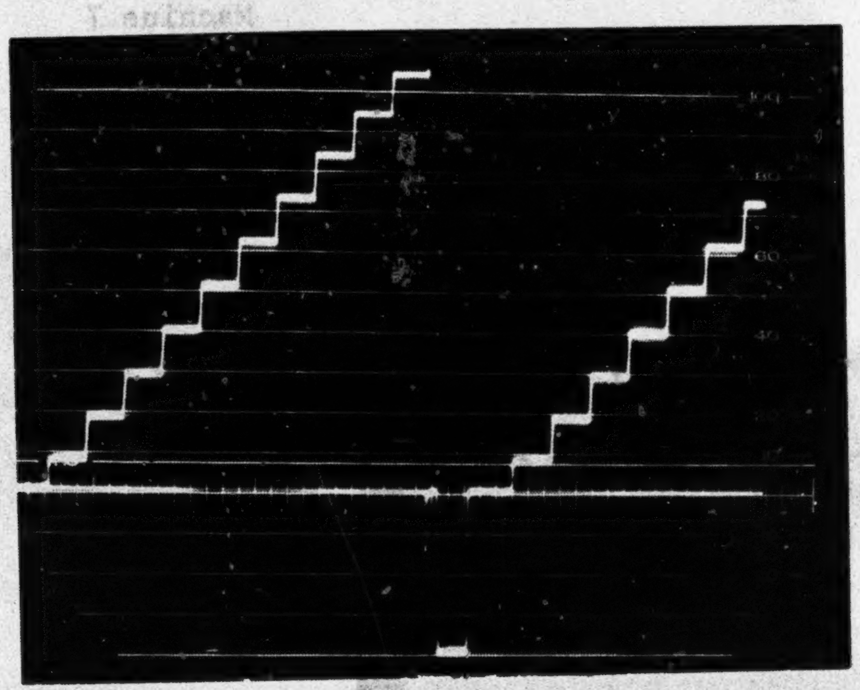


Fig. 7-7 Calibration Stairstep

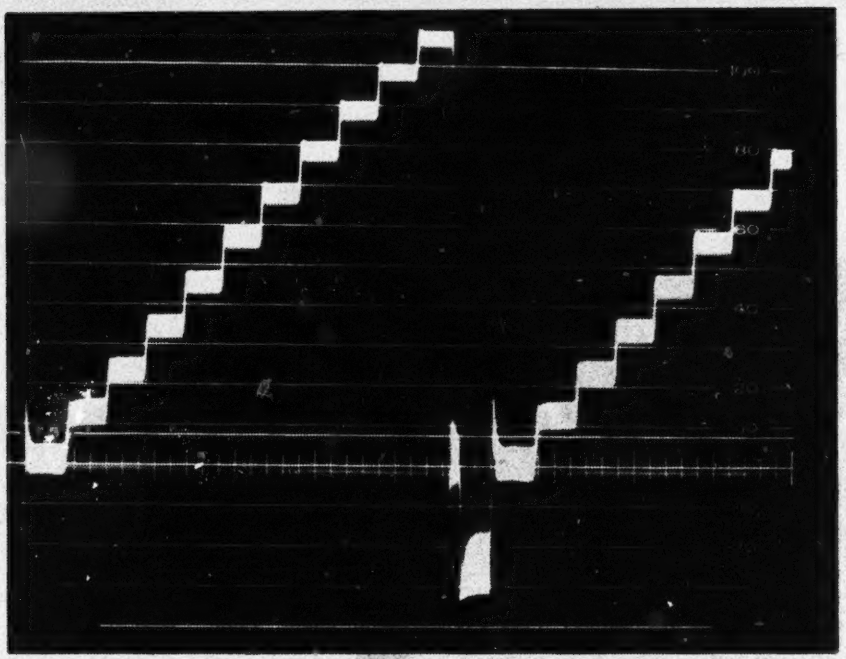


Fig. 7-8 Stairstep Loop-Through

Loop-through level is 10% high. Differential gain distortion is approximately 3%. Carrier leak through extremely bad.

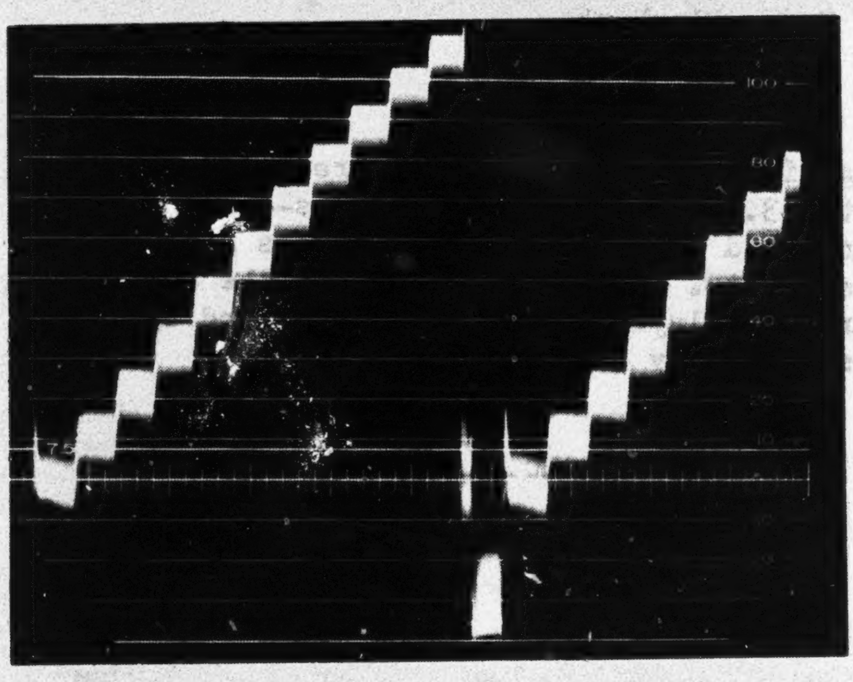


Fig. 7-9 Stairstep Playback

Playback level is about 11% high. Differential gain distortion is about 2%. Noise and carrier leak through is extremely bad.

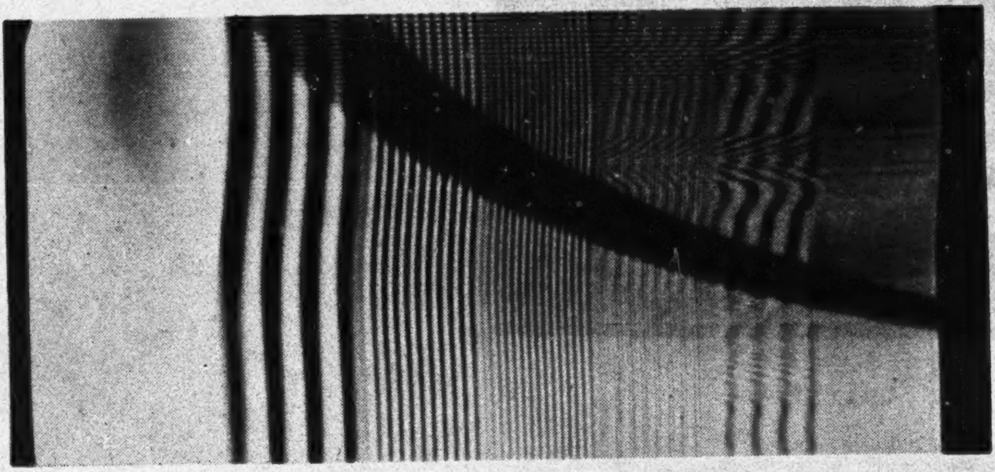


Fig. 7-10 Multiburst "A" Scope Loop-Through

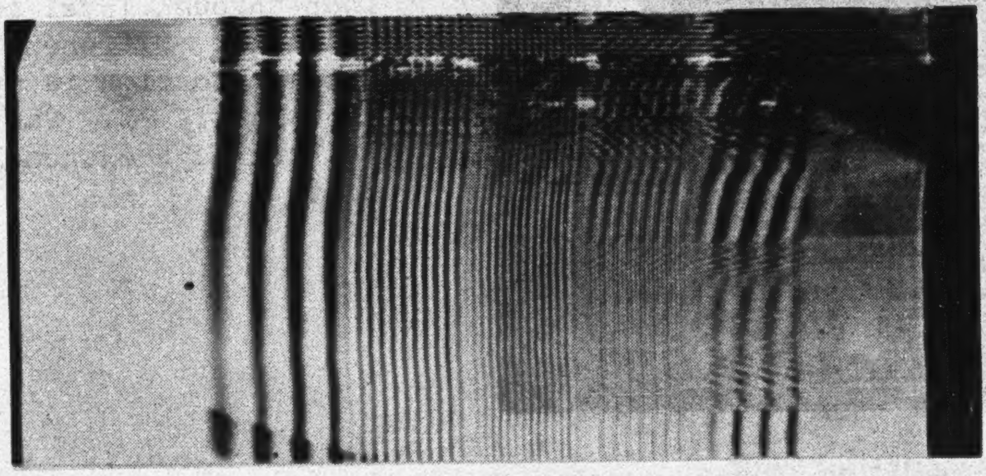


Fig. 7-11 Multiburst "A" Scope Playback

The electronic loop-through in the PI-3V video tape recorder shows a breakup of portions of the 3.2 MHz and 3.6 MHz bursts--an effect which is time dependent in field time. The effect causes a total breakup in portions of the bursts. The double lines on the bottom portion of the 3.2 MHz burst on playback are probably caused by ringing in the electronics caused by high frequency peaking circuits.

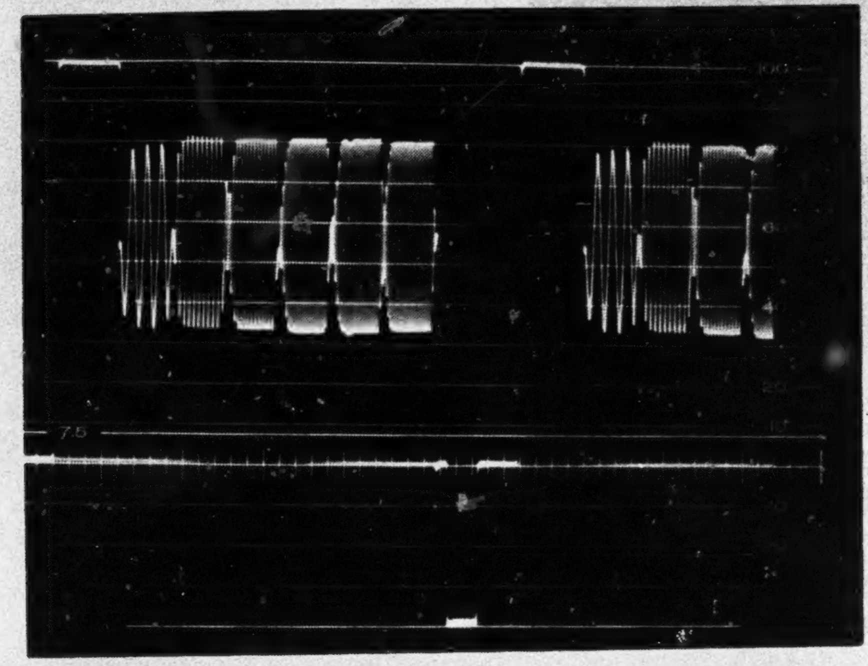
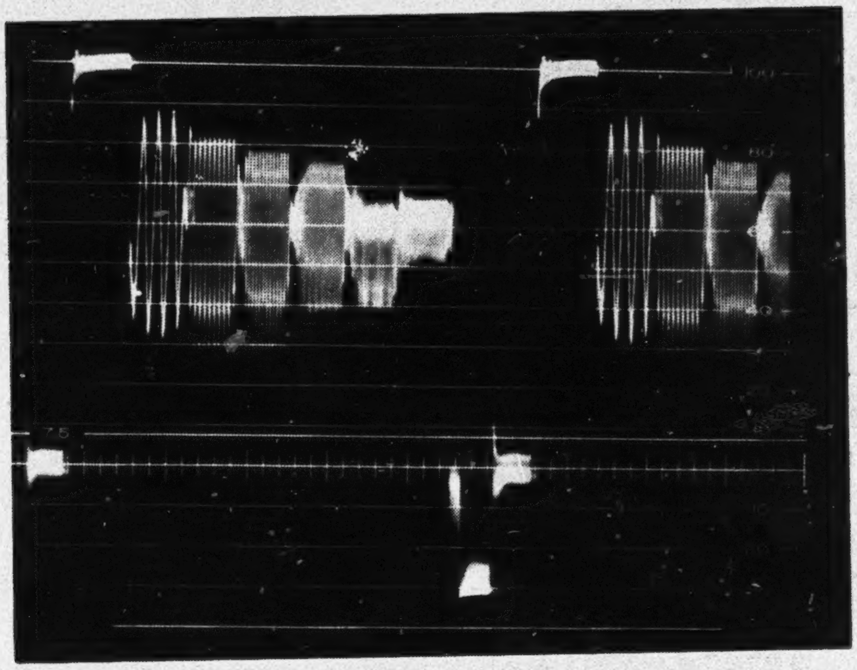
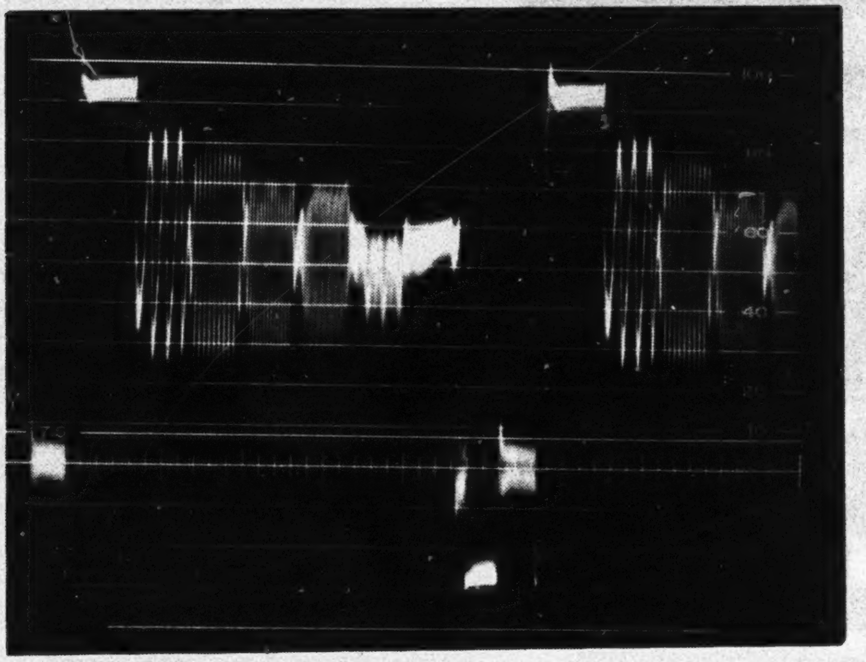


Fig. 8-1 Calibration Multiburst



Flag indicates ringing and high frequency roll-off. Multiburst indicates interference between video information and carrier. Response down approximately 28% at 3.2 MHz. Sync level is 10% short. Carrier feed through is approximately 8%.

Fig. 8-2 Multiburst Loop-Through



The output level is 7% low. High frequency ringing. Multiburst signals indicate interference between video information and carrier frequency. Sync level is approximately 11% low. Bad noise and carrier leak through.

Fig. 8-3 Multiburst Playback

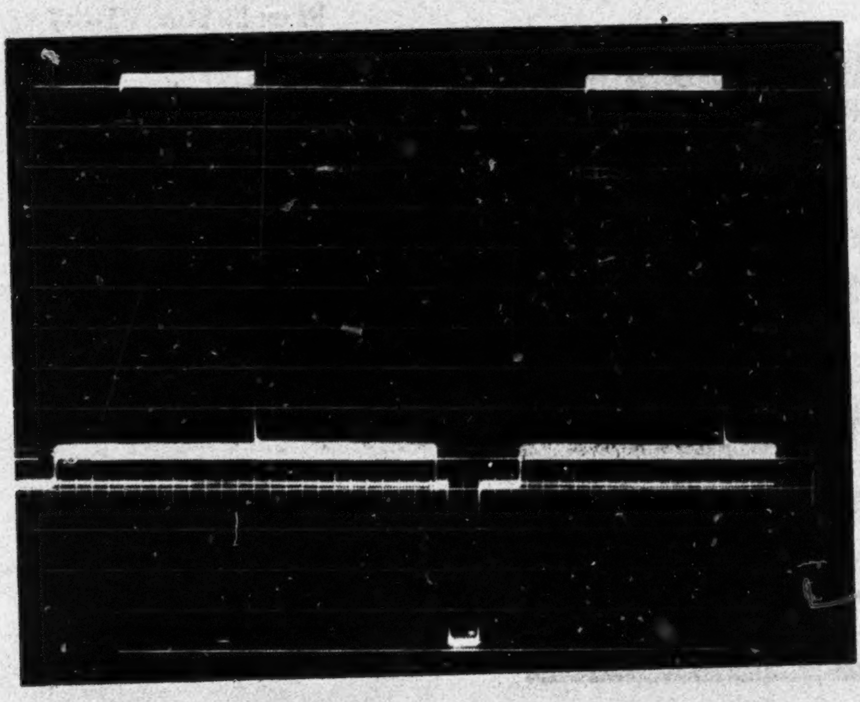
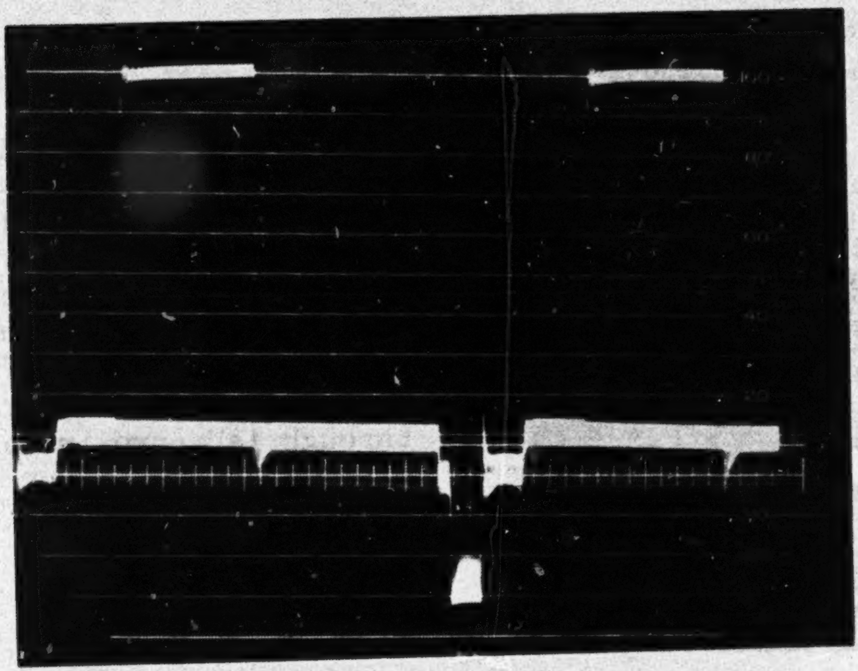
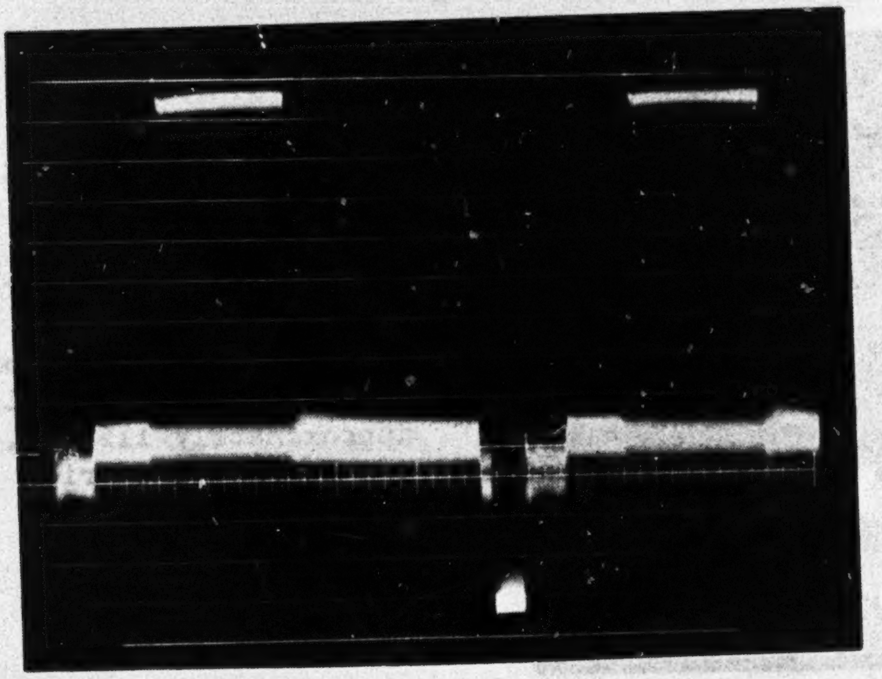


Fig. 8-4 Calibration Window



Window loop-through indicates ringing and carrier leak through.

Fig. 8-5 Window Loop-Through



Window playback level is approximately 5% low. Indicates high frequency ringing. Bad noise and carrier leak through.

Fig. 8-6 Window Playback

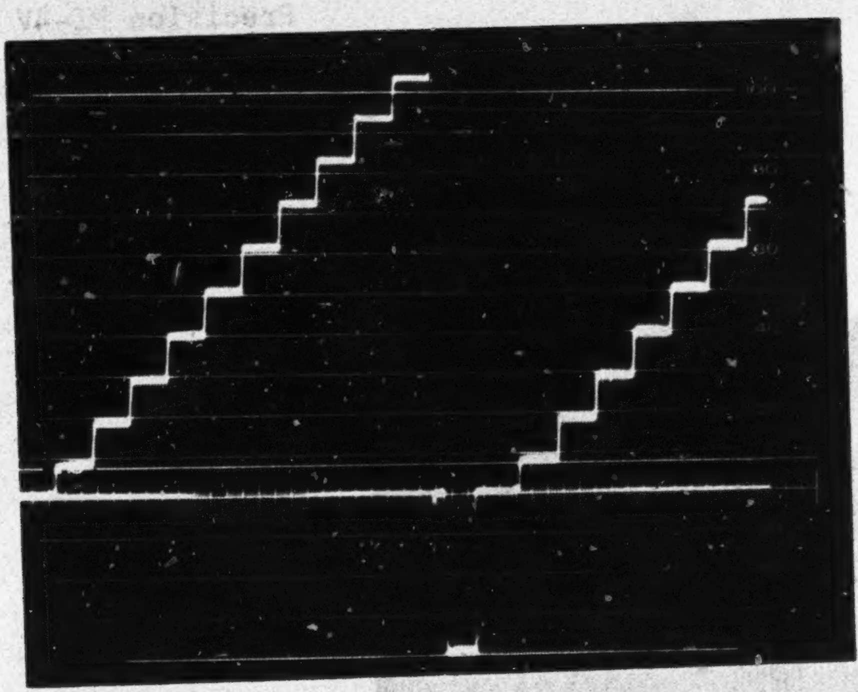


Fig. 8-7 Calibration Stairstep

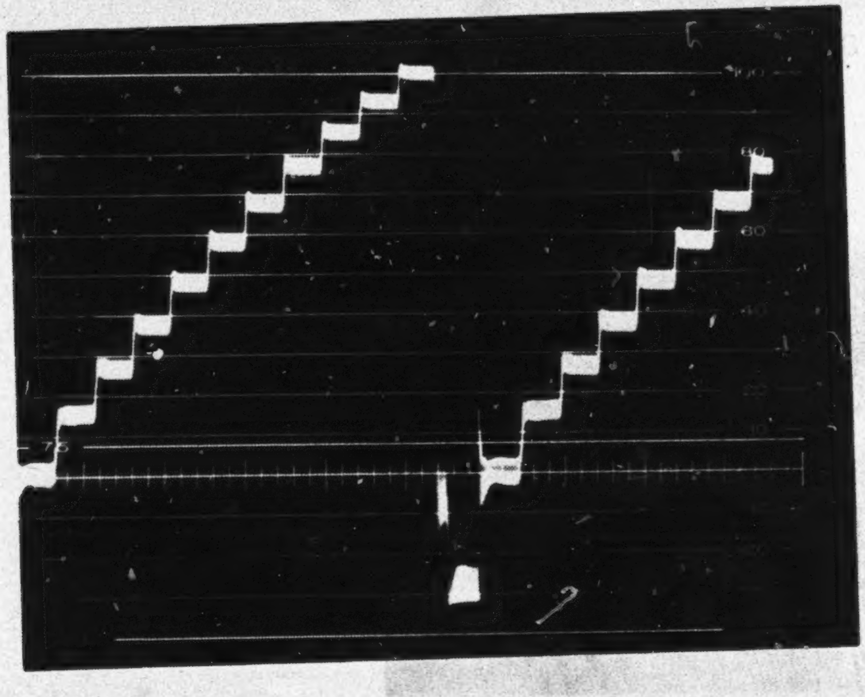


Fig. 8-8 Stairstep Loop-Through

The differential gain distortion is approximately 5%. Bad carrier leak through.

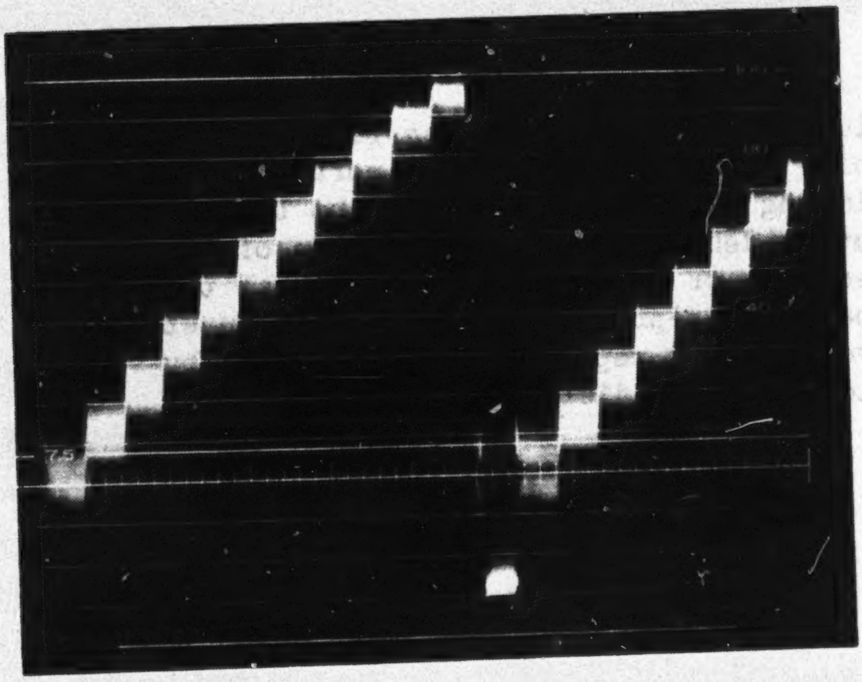


Fig. 8-9 Stairstep Playback

The differential gain distortion is approximately 4% to 5%. Bad noise and carrier leak through.

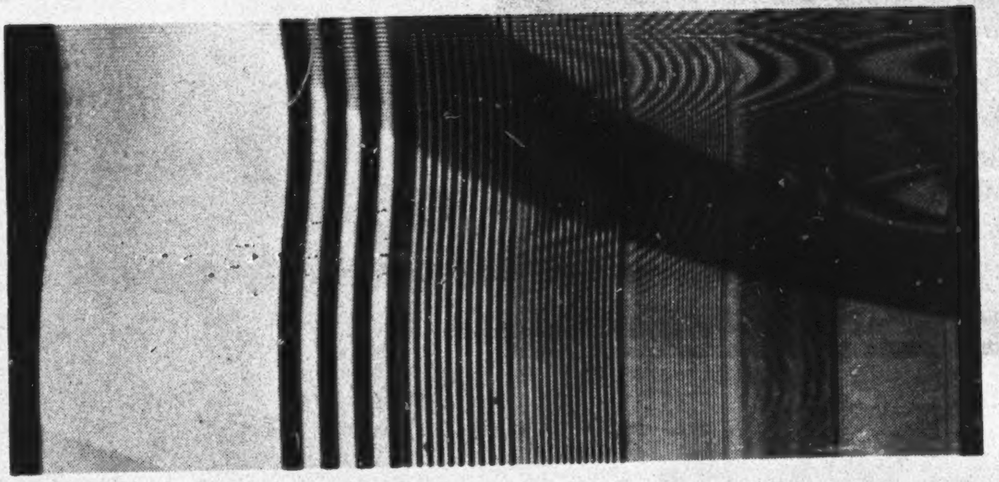


Fig. 8-10 Multiburst "A" Scope Loop-Through

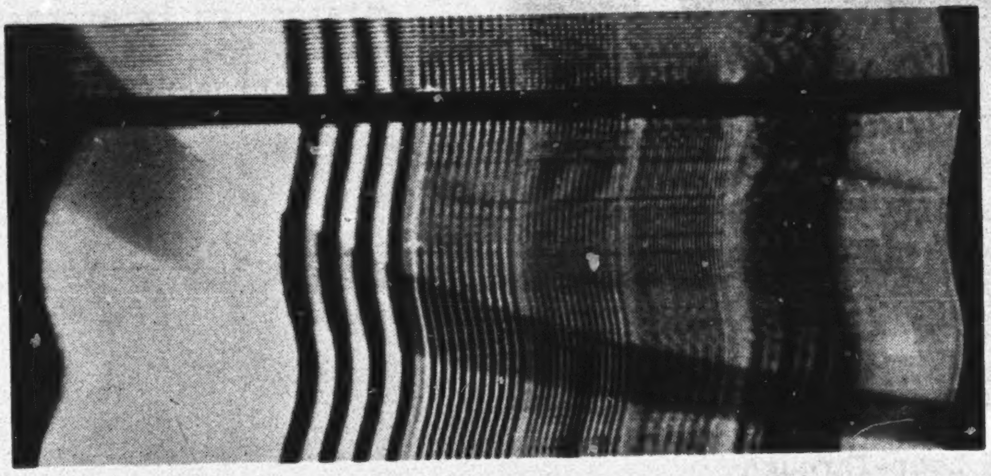


Fig. 9-11 Multiburst "A" Scope Playback

Extraneous signals are evident in a portion of the field on loop-through as shown by the moire pattern on the upper portion of the "A" scope picture. The ringing is evidently related to the vertical sync pulse as it is not evident on the lower portion of the picture. The frequency response of the playback shows that the video tape recorder is capable of reproducing the 3.2 MHz bursts. The vertical sync pulses were poorly reproduced as evidenced by the vertical bar in the picture. "S" distortion was excessive.

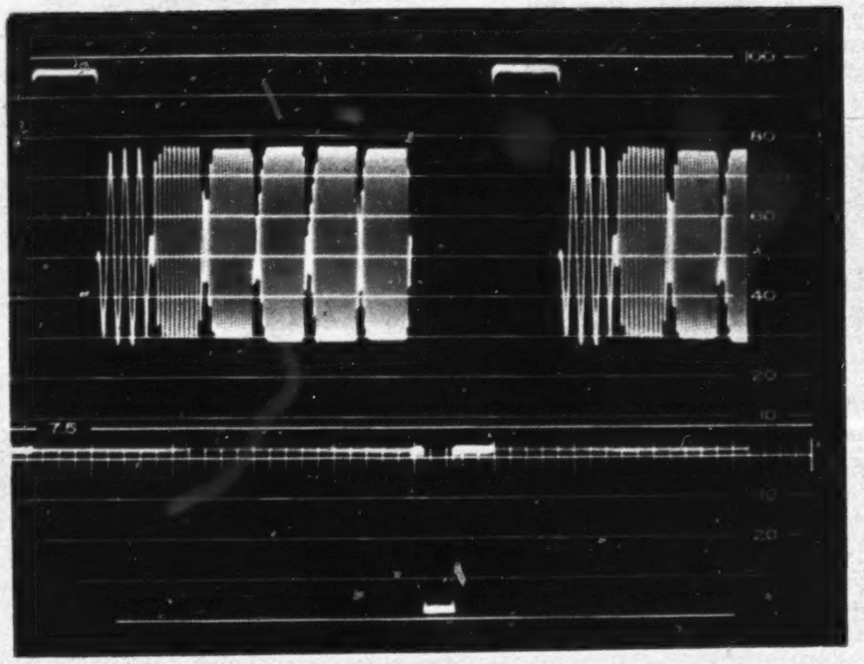
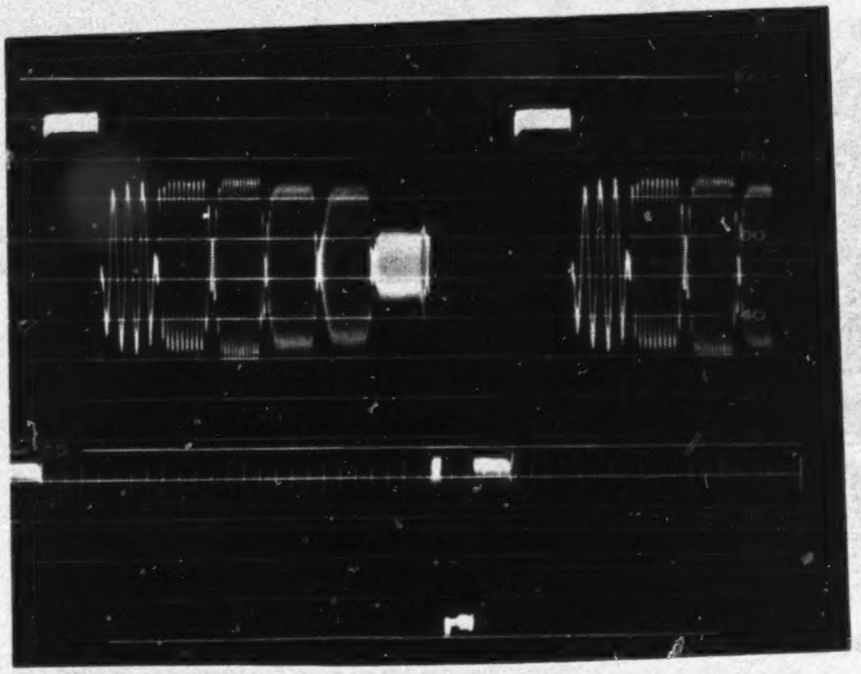
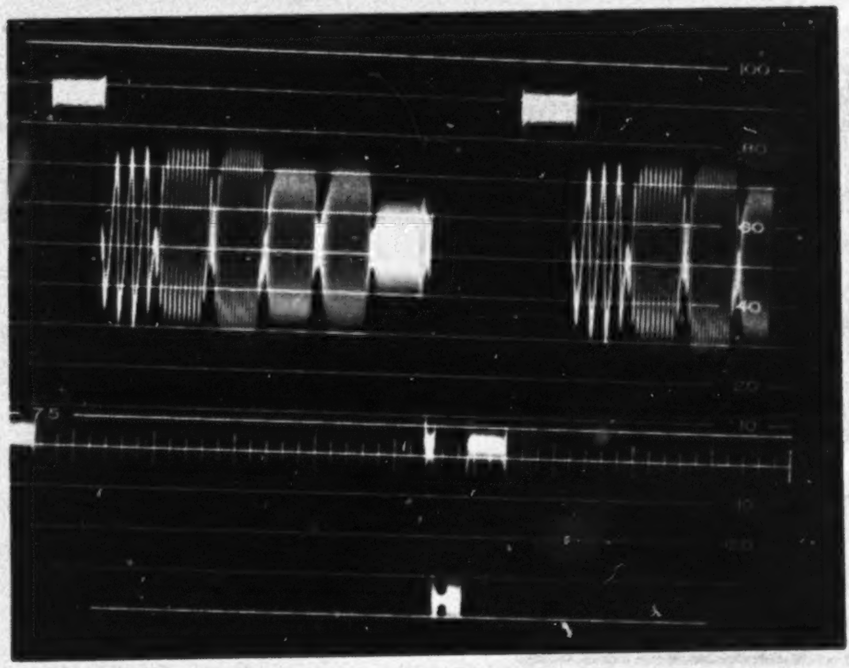


Fig. 9-1 Calibration Multiburst



The output level is approximately 10% down. Frequency response excellent to 3.6 MHz. Over 50% down at 4.2 MHz.

Fig. 9-2 Multiburst Loop-Through



The output level is approximately 10% down. Frequency response excellent to 3.6 MHz. Over 50% down at 4.2 MHz. Some noise and carrier leak through.

Fig. 9-3 Multiburst Playback

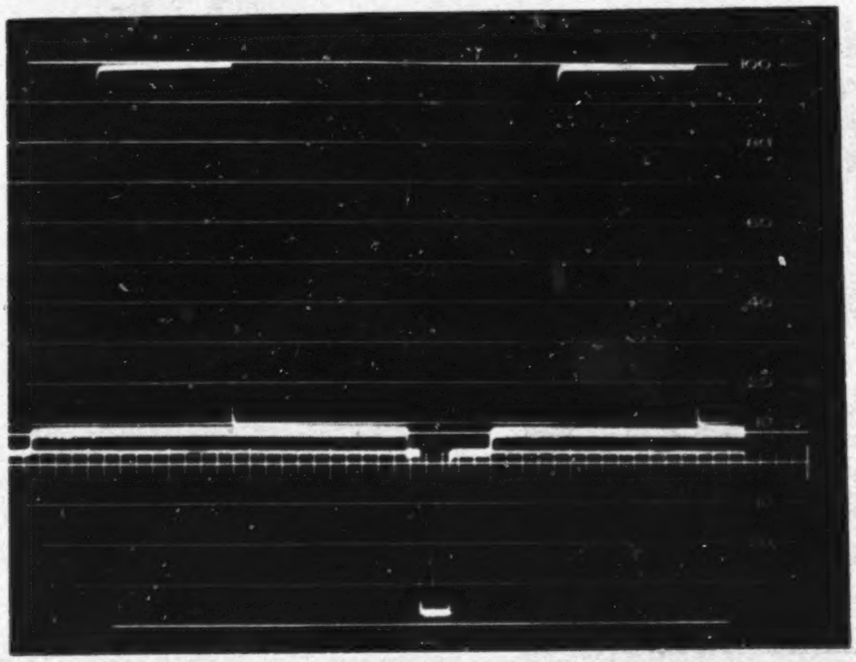
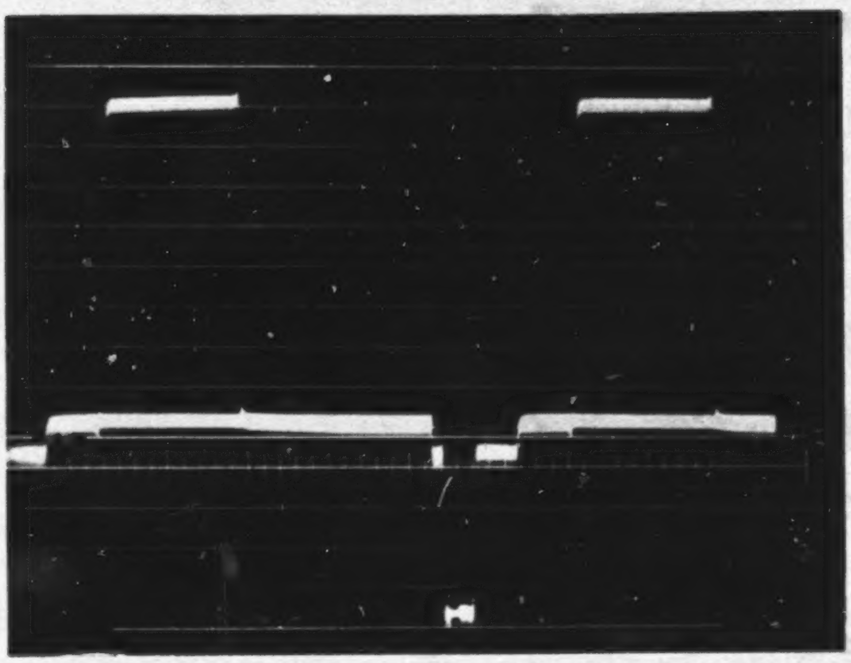
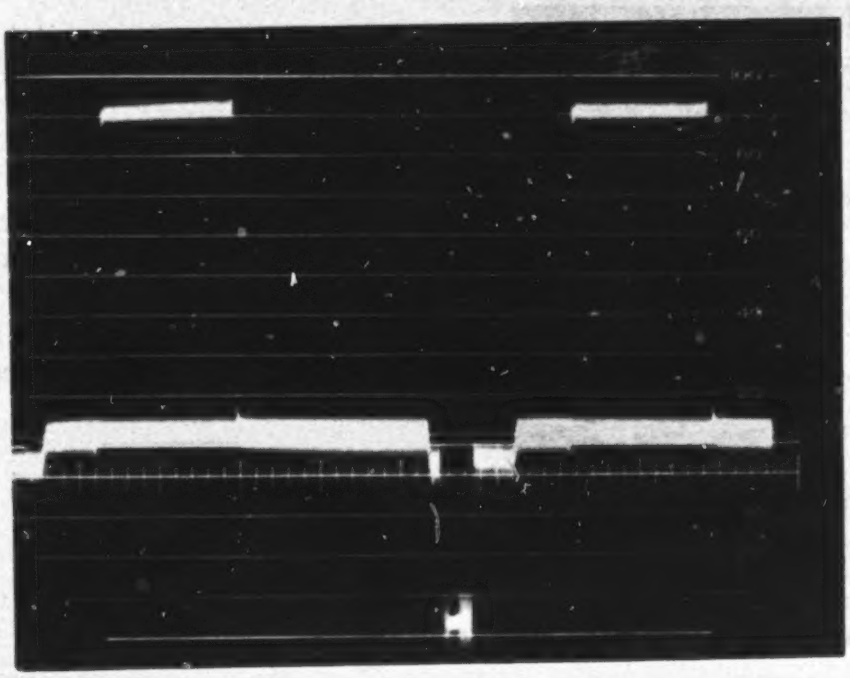


Fig. 9-4 Calibration Window



The output level is approximately 15% down. Some carrier feed through.

Fig. 9-5 Window Loop-Through



Output level is 10% down. Some noise and carrier leak through.

Fig. 9-6 Window Playback

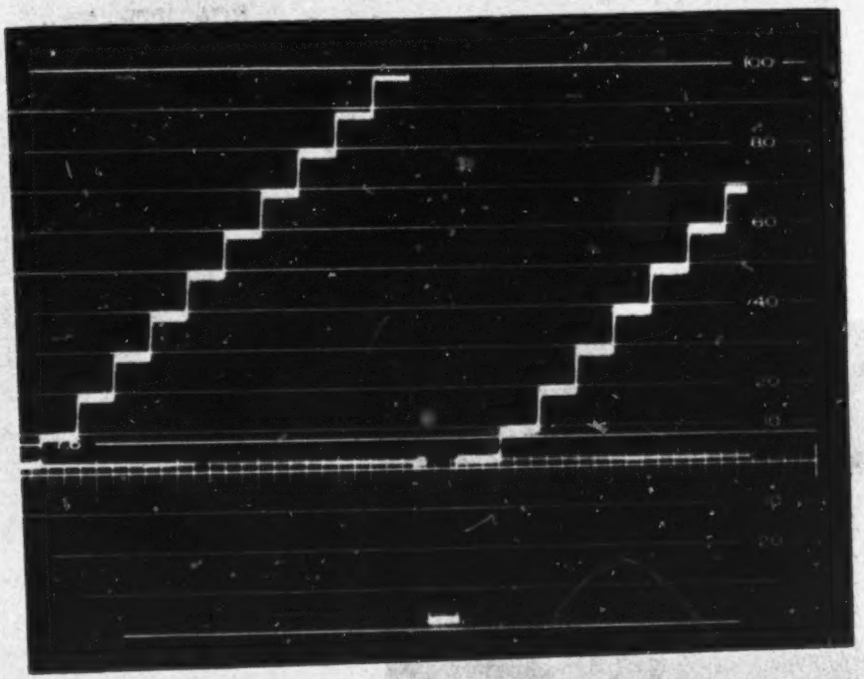


Fig. 9-7 Calibration Stairstep

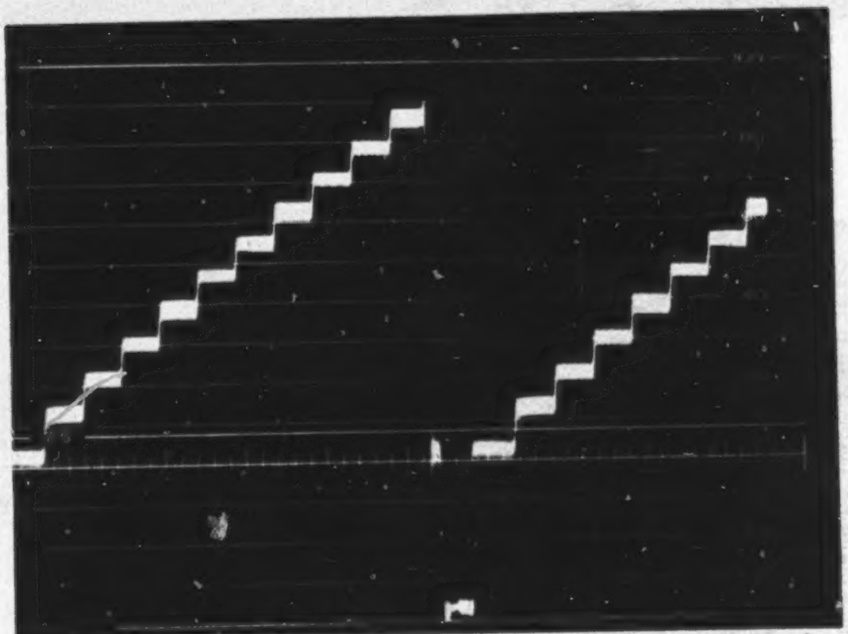


Fig. 9-8 Stairstep Loop-Through

The differential gain is excellent. Some carrier leak through.

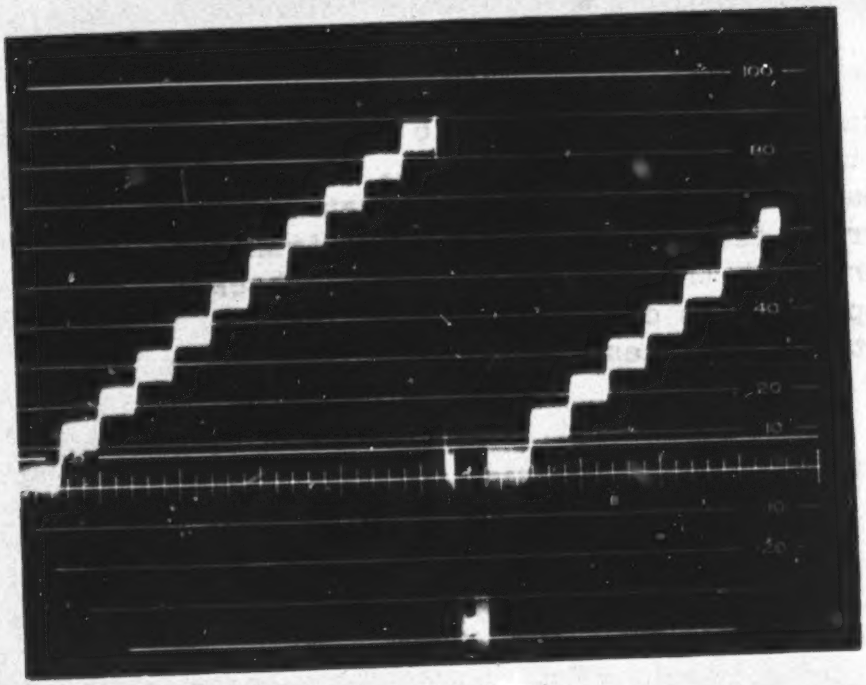


Fig. 9-9 Stairstep Playback

The differential gain is excellent. Carrier plus noise leak through.

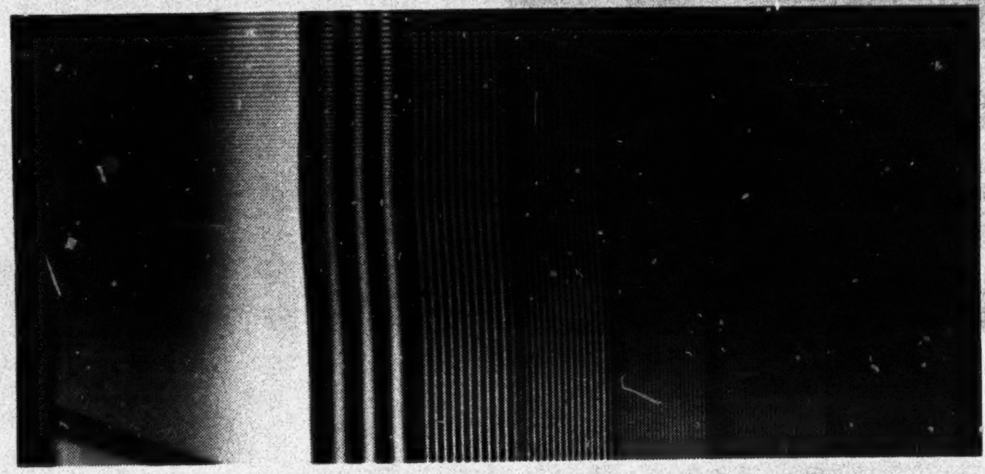


Fig. 9-10 Multiburst "A" Scope Loop-Through

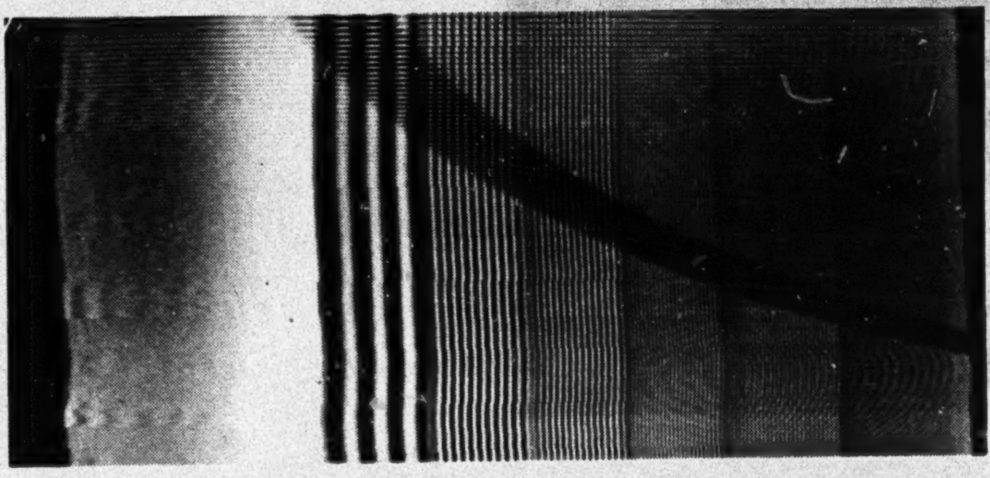


Fig. 9-11 Multiburst "A" Scope Playback

Loop-through electronics was excellent through 3.6 MHz and the playback was equally good through the 3.6 MHz burst. Some moire patterns are seen on playback through the 4.2 MHz burst and these probably are caused by carrier feed-through or other extraneous signals. The effect differs with the several record-playback heads. Each of the quadrapole heads can be identified by the slight skew or displacement for 34 lines.

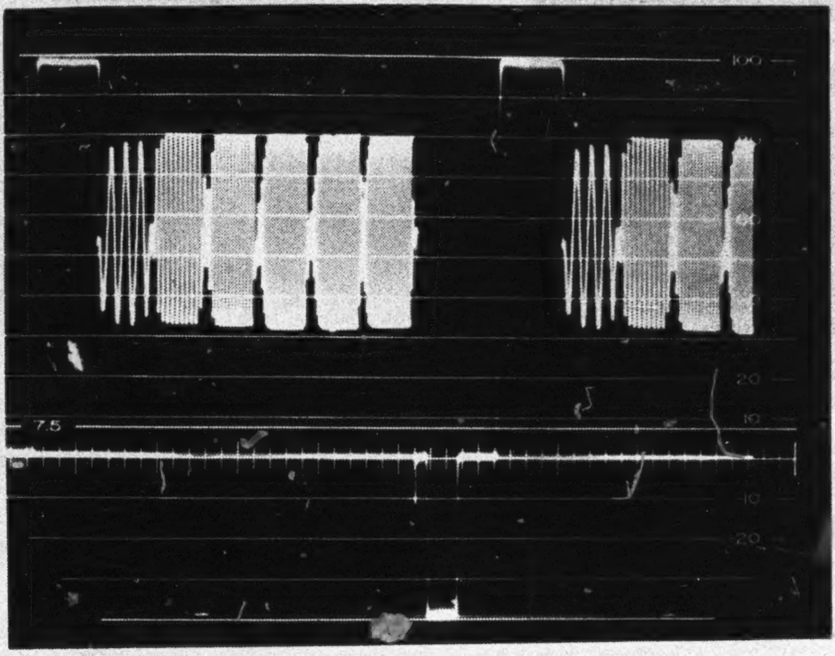


Fig. 10-1 Calibration Multiburst

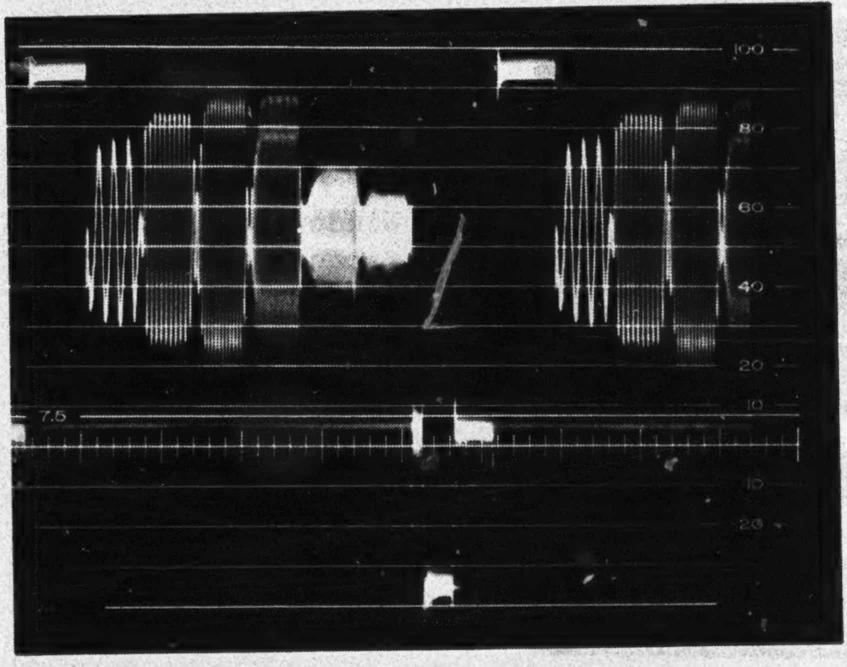


Fig. 10-2 Multiburst Loop-Through

High frequency peaking and ringing indicated. Mid-frequency of burst accentuated as compared to low and high frequency of burst. Output level is approximately 7% low.

(Note: As the video input level was changed, the fifth and sixth bursts went through a series of strange nulls.)

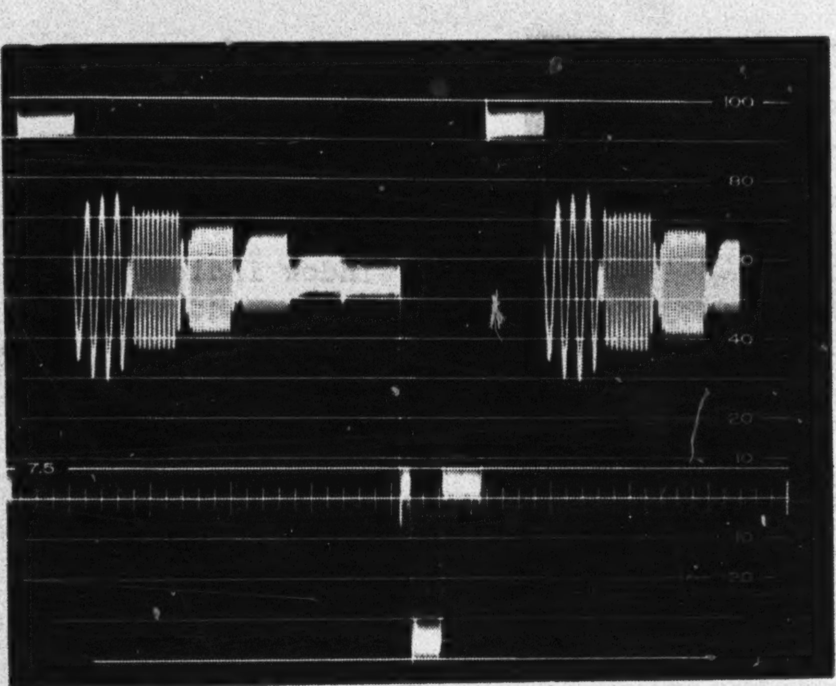


Fig. 10-3 Multiburst Playback

The output level is approximately 8-1/2% low. Frequency response is approximately 30% at 2 MHz. Irregular distortion noticed in last three bursts. Some carrier plus noise leak through.

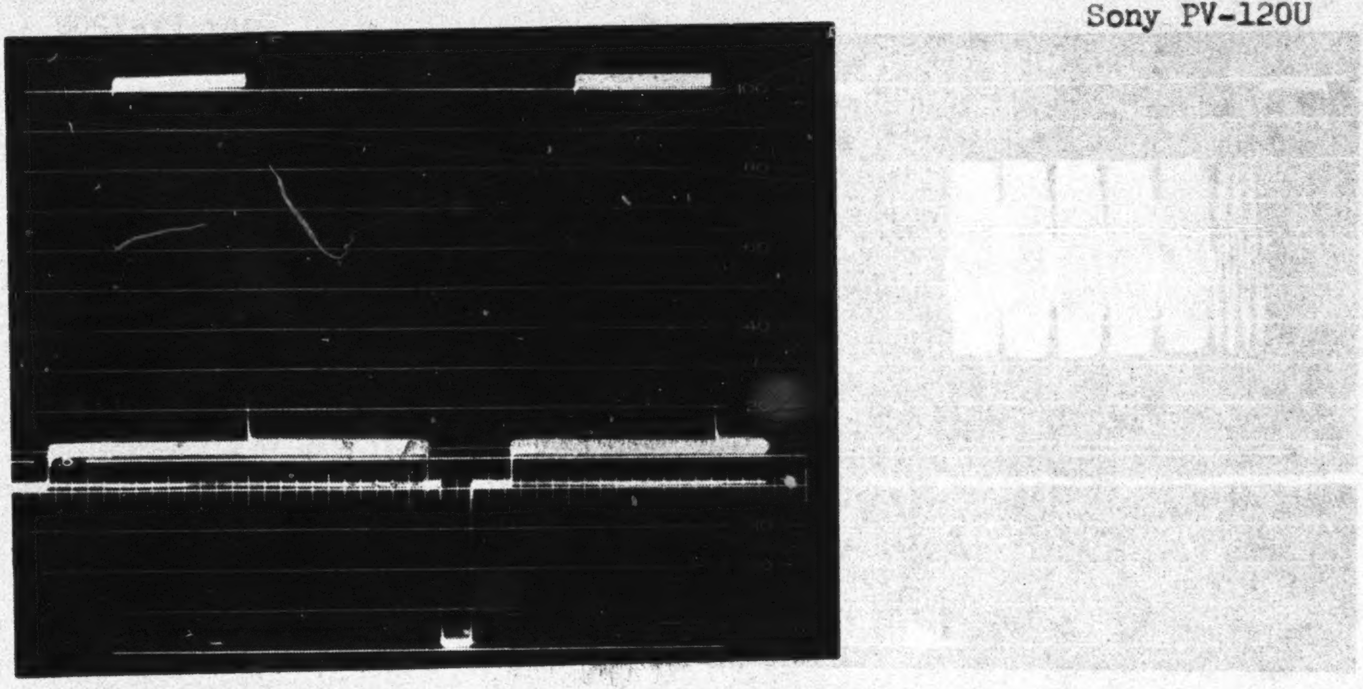
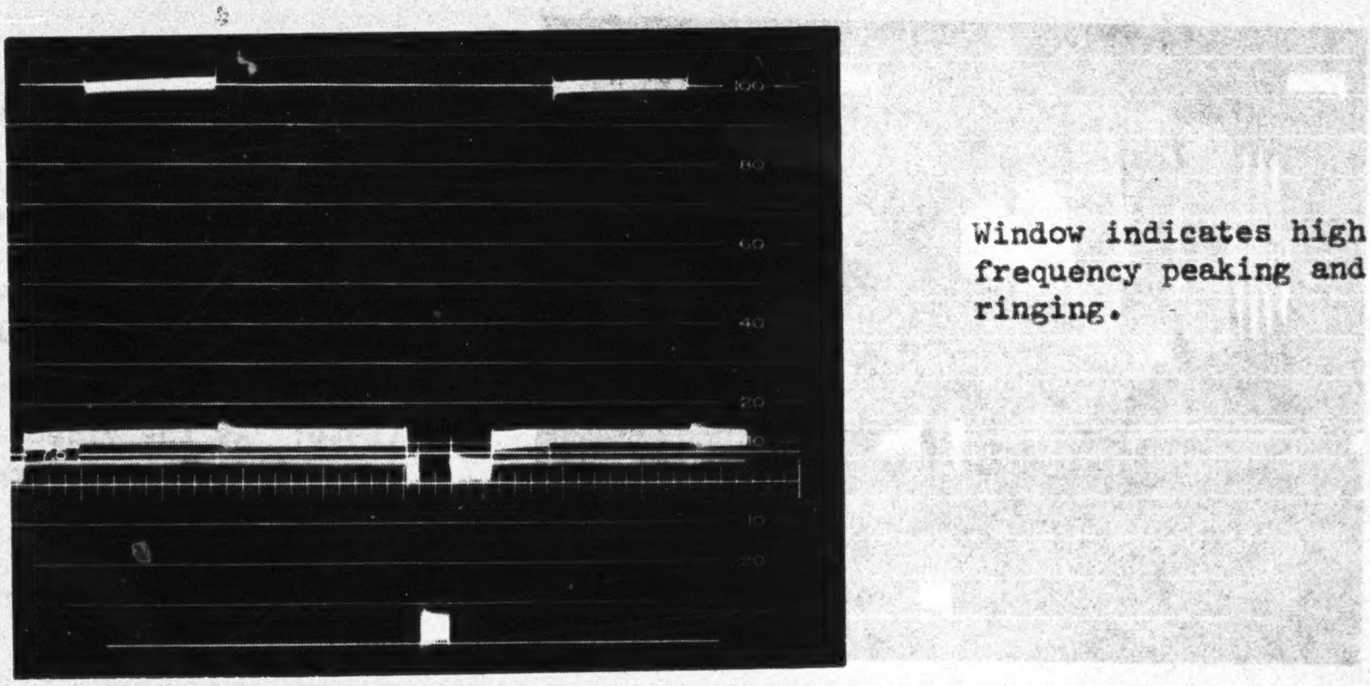
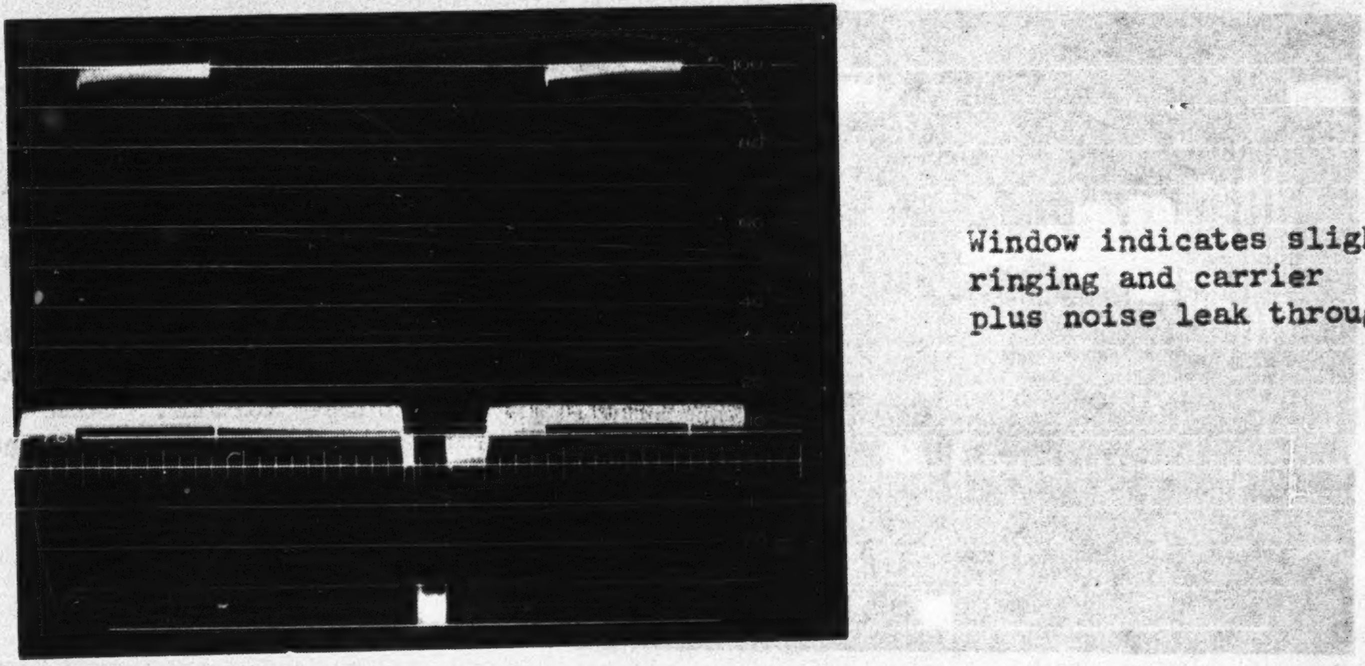


Fig. 10-4 Calibration Window



Window indicates high frequency peaking and ringing.

Fig. 10-5 Window Loop-Through



Window indicates slight ringing and carrier plus noise leak through.

Fig. 10-6 Window Playback

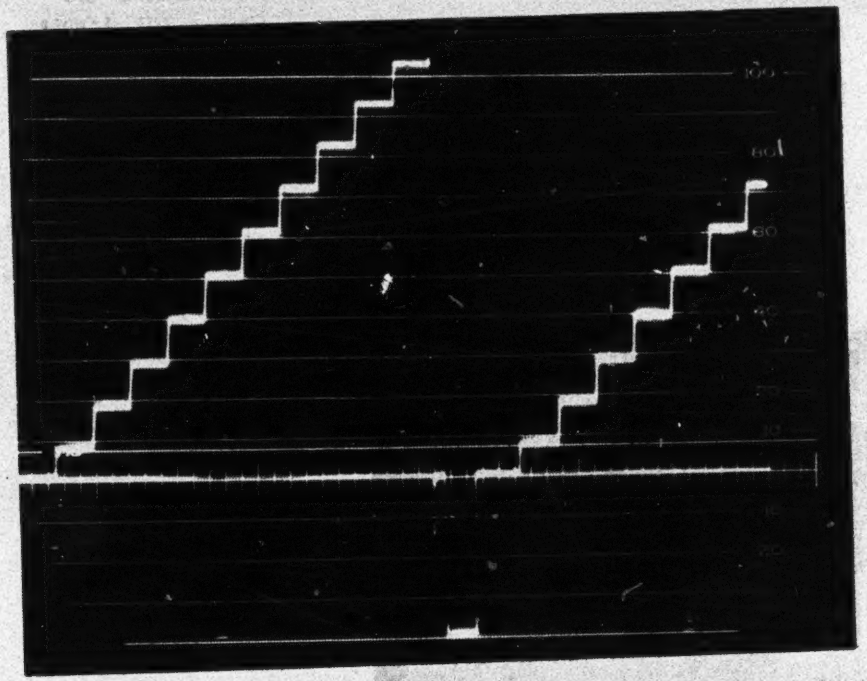


Fig. 10-7 Calibration Stairstep

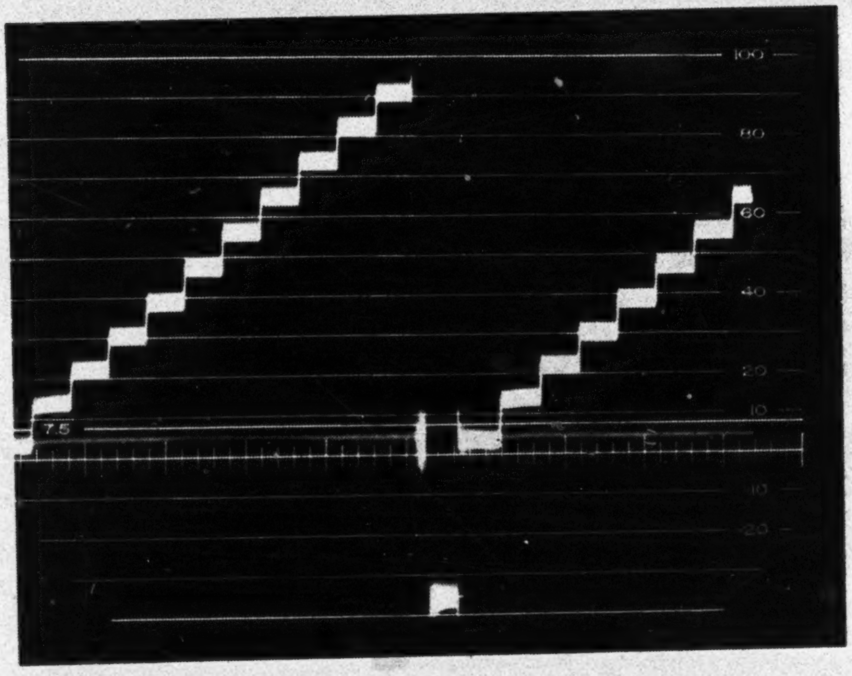


Fig. 10-8 Stairstep Loop-Through

The differential gain is extremely good. Some carrier leak through.

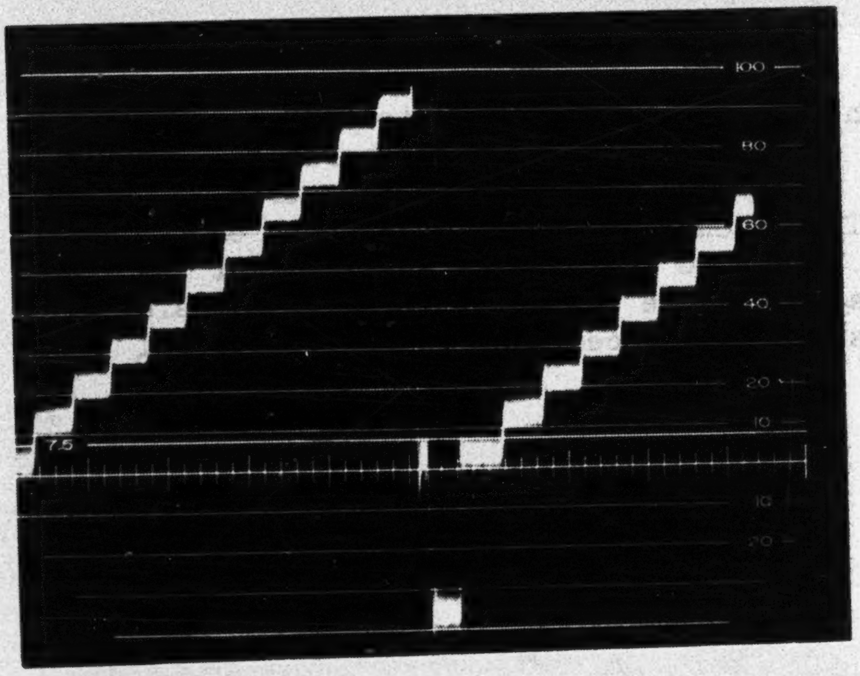


Fig. 10-9 Stairstep Playback

The differential gain is good. Carrier plus noise leak through.

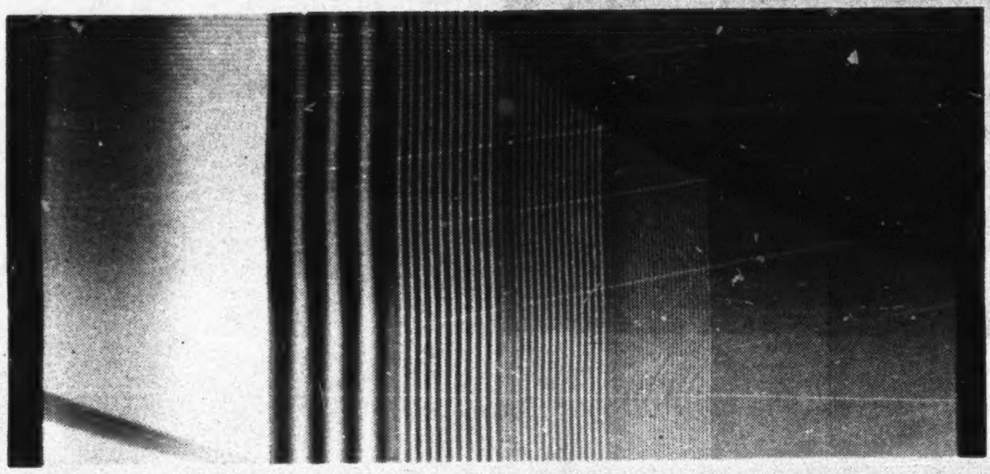


Fig. 10-10 Multiburst "A" Scope Loop-Through

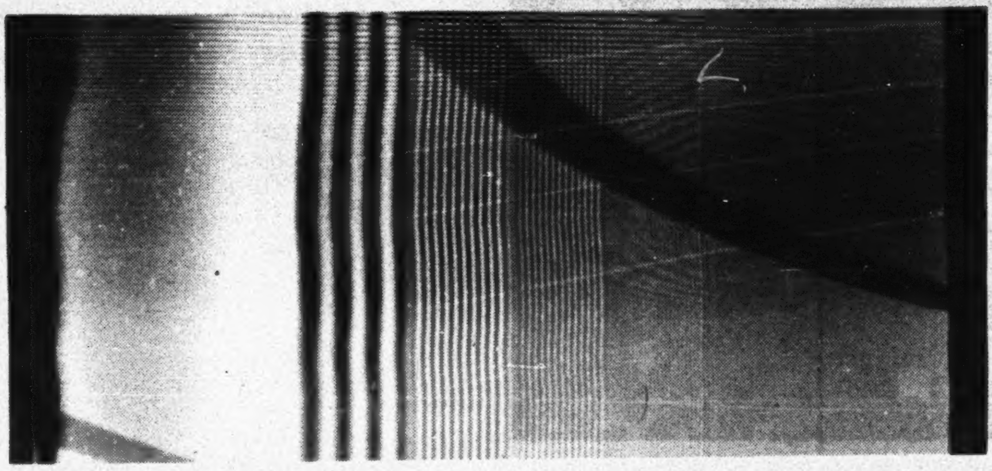


Fig. 10-11 Multiburst "A" Scope Playback

The electronic loop-through picture shows satisfactory reproduction through the 3.2 MHz burst. On playback the 3.2 MHz burst is just visible and a small amount of carrier leak through or extraneous signal causes the moire. The absence of the moire pattern on the 3.6 MHz and 4.2 MHz bursts is due to the lack of a sufficient signal in these frequencies to produce the interference. Satisfactory horizontal sync pulses are reproduced to lock the horizontal drive oscillator.

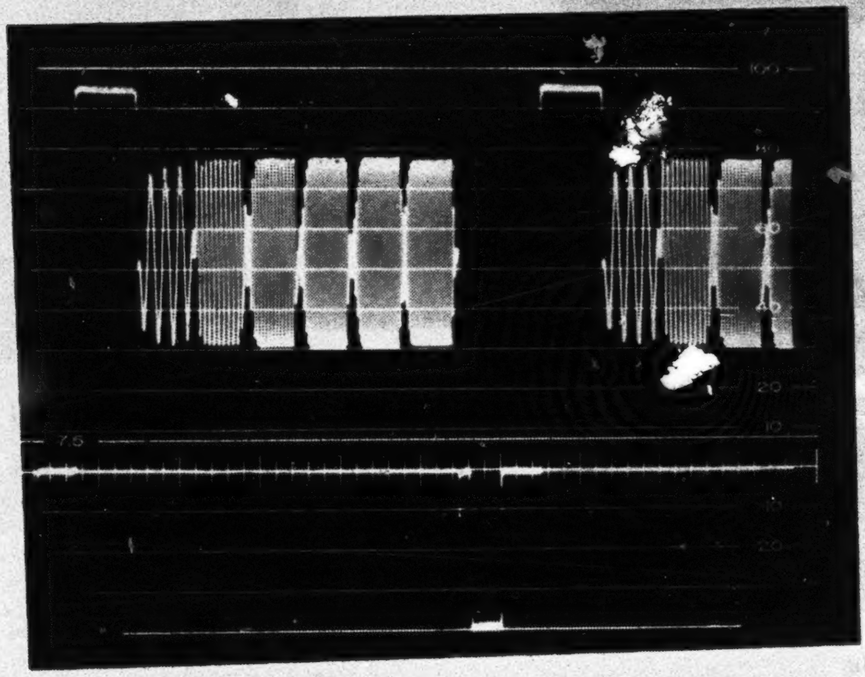


Fig. 11-1 Calibration Multiburst

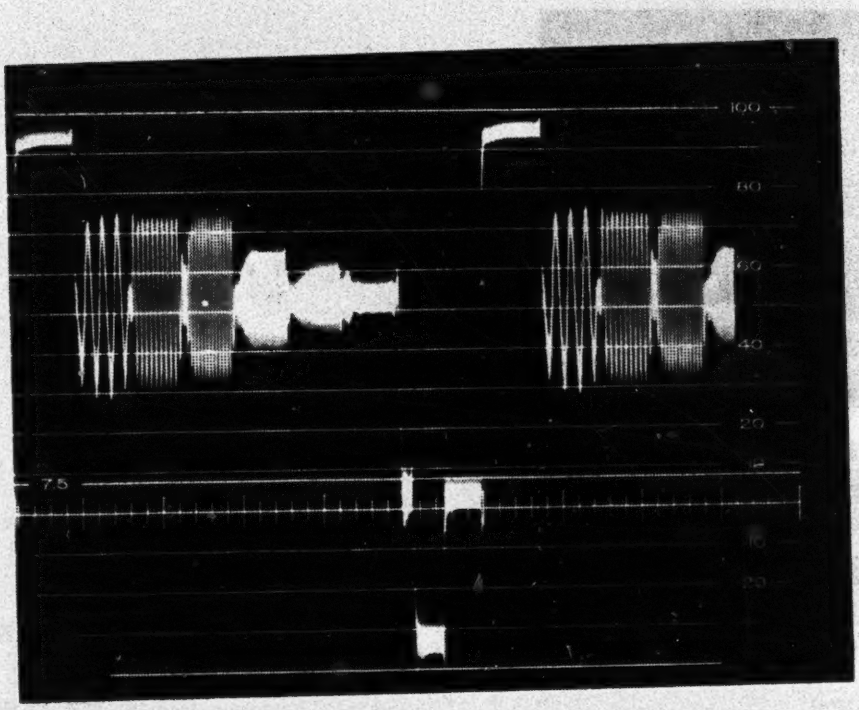


Fig. 11-2 Multiburst Loop-Through

Flag indicates some high frequency ringing plus low frequency accentuation. Frequency response 50% down at 3.2 MHz. Some carrier leak through.

(Note: The last three bursts on the multiburst went through a series of nulls with a change when the video input level was changed.)

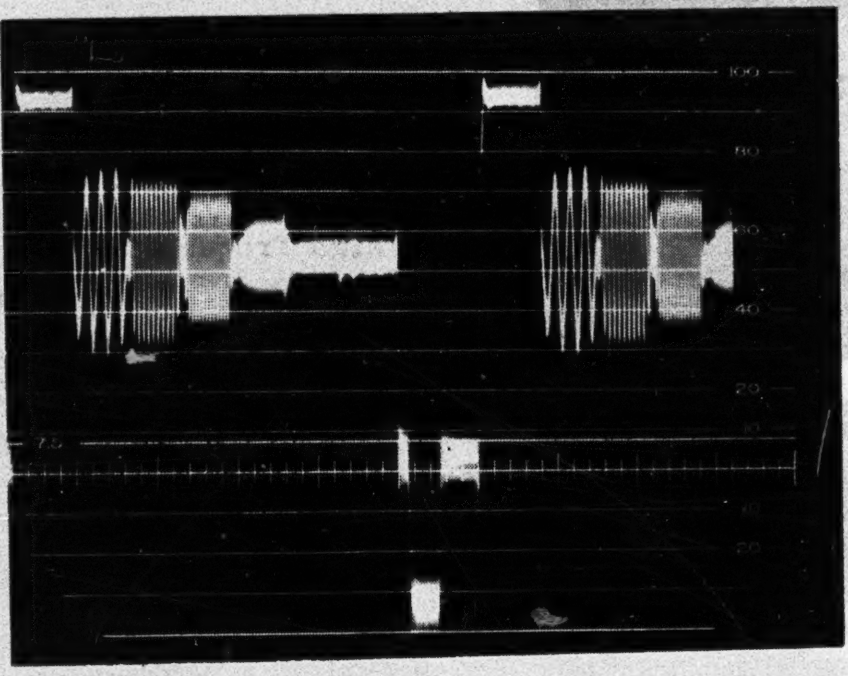


Fig. 11-3 Multiburst Playback

High frequency ringing indicated on flag burst. Frequency response down 30% by 2 MHz. Noise and carrier leak through.

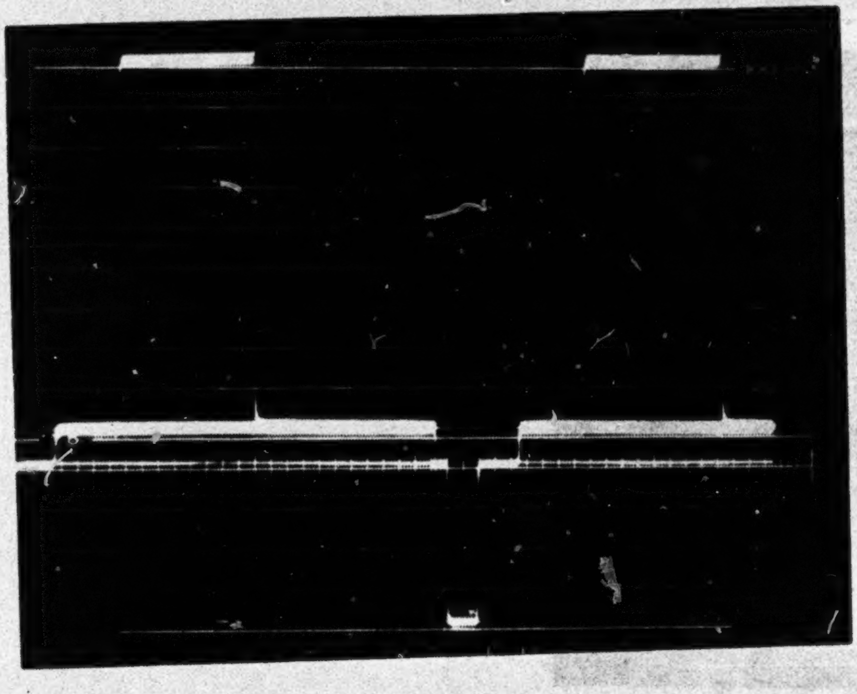
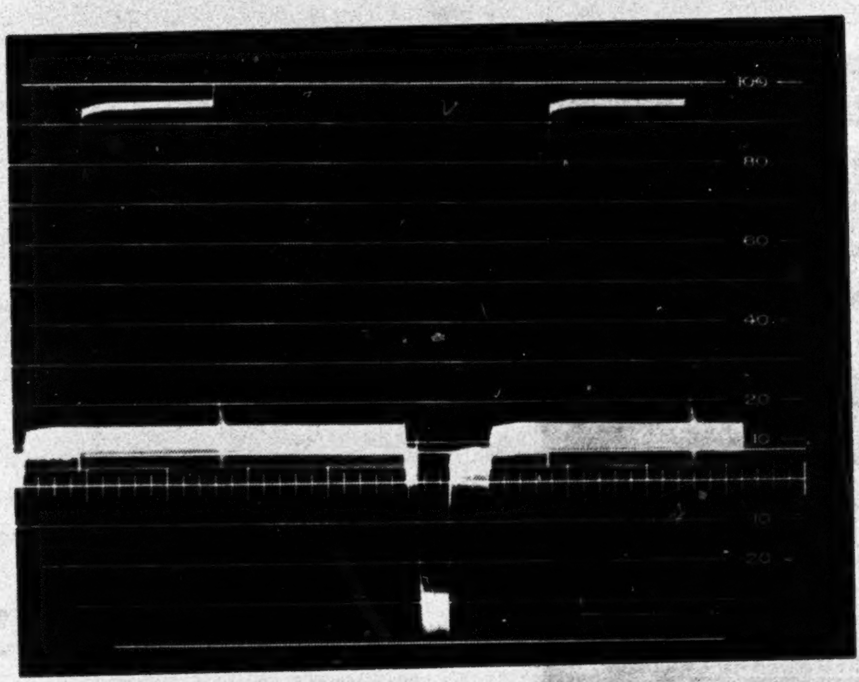
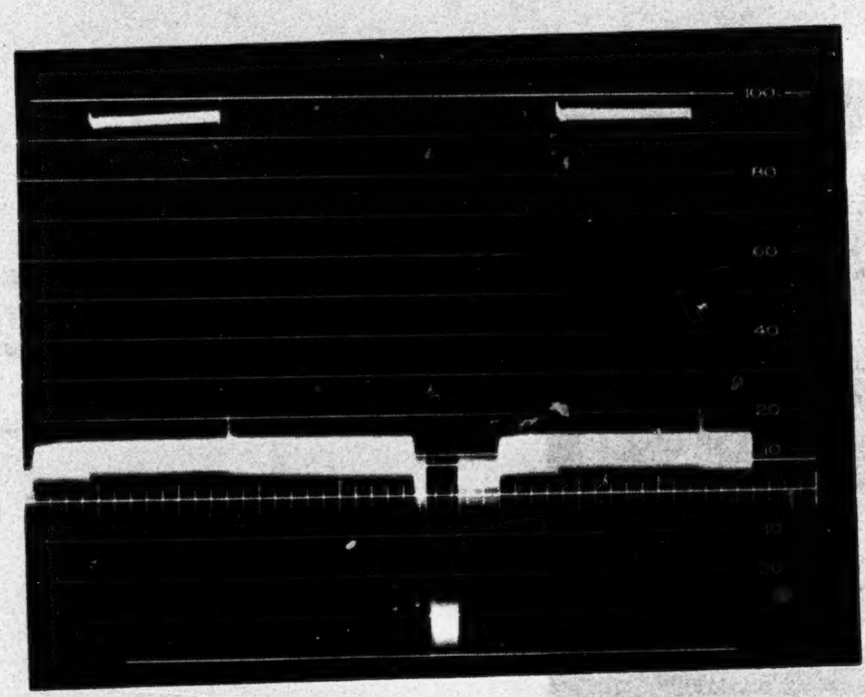


Fig. 11-4 Calibration Window



Carrier leak through and high frequency ringing.

Fig. 11-5 Window Loop-Through



High frequency ringing, carrier leak through, and noise.

Fig. 11-6 Window Playback

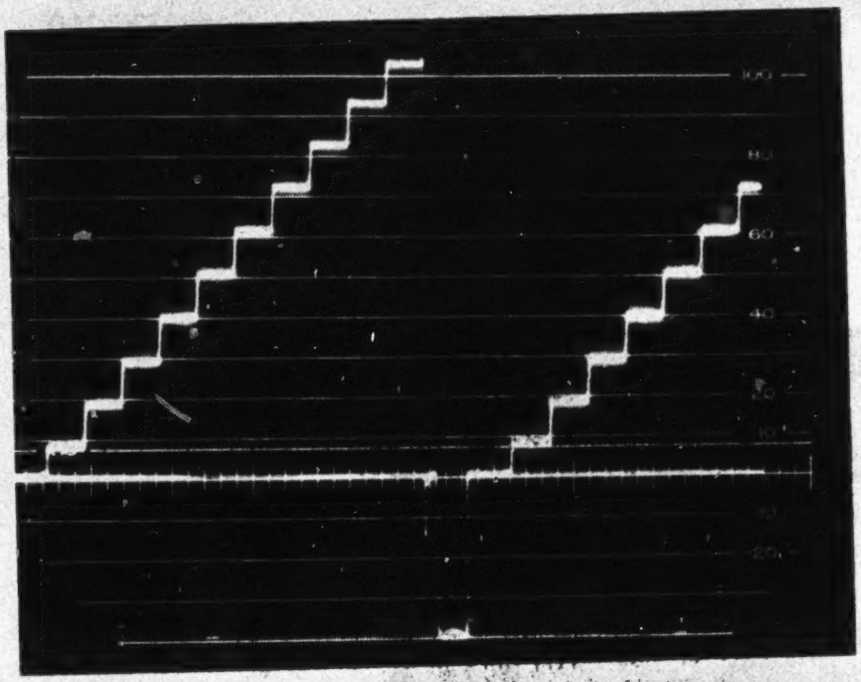


Fig. 11-7 Calibration Stairstep

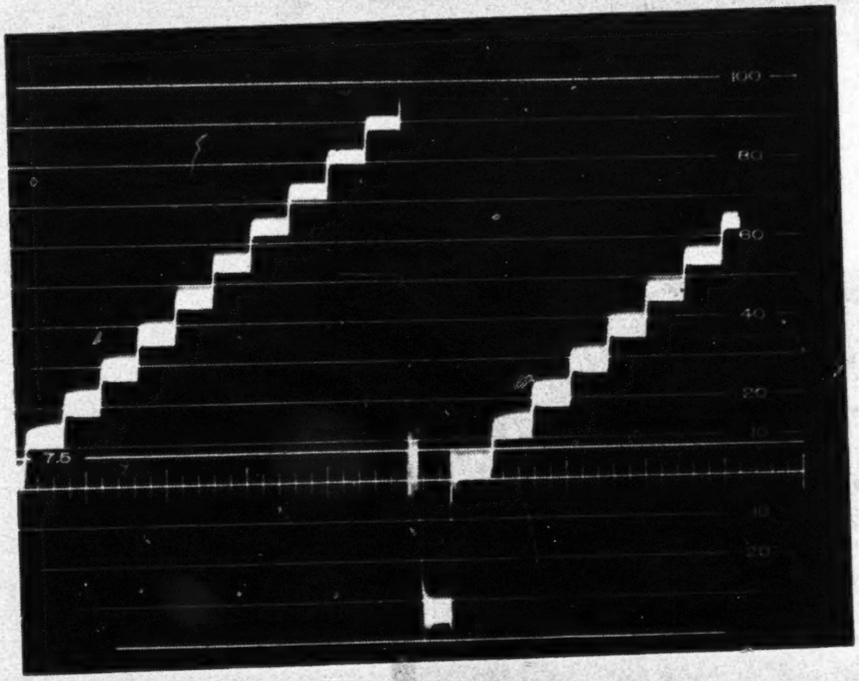


Fig. 11-8 Stairstep Loop-Through

The differential gain is excellent. Carrier leak through.

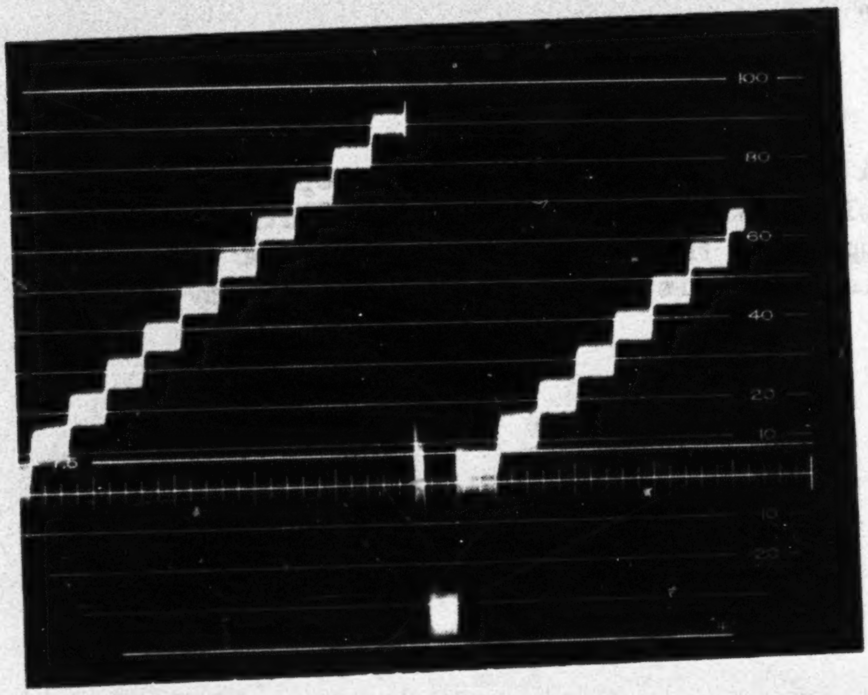


Fig. 11-9 Stairstep Playback

The differential gain is good. Carrier leak through plus noise.

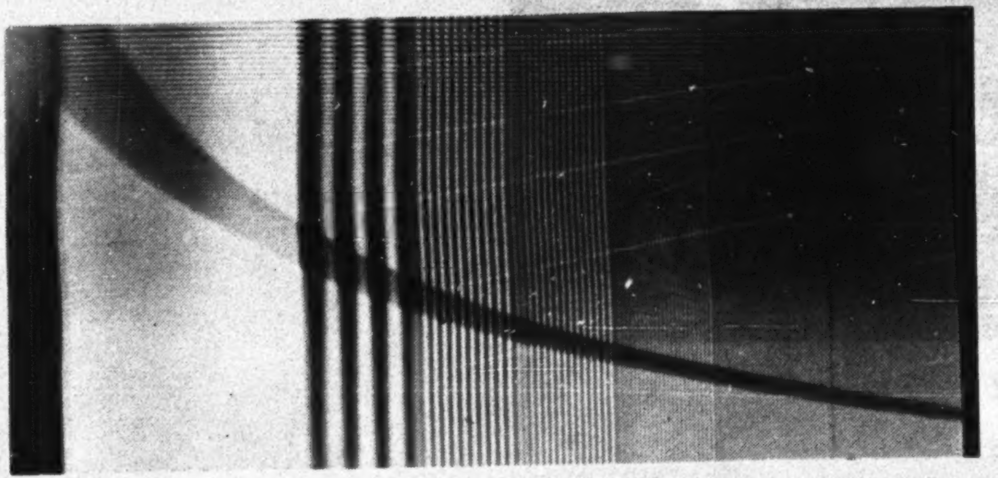


Fig. 11-10 Multiburst "A" Scope Loop-Through

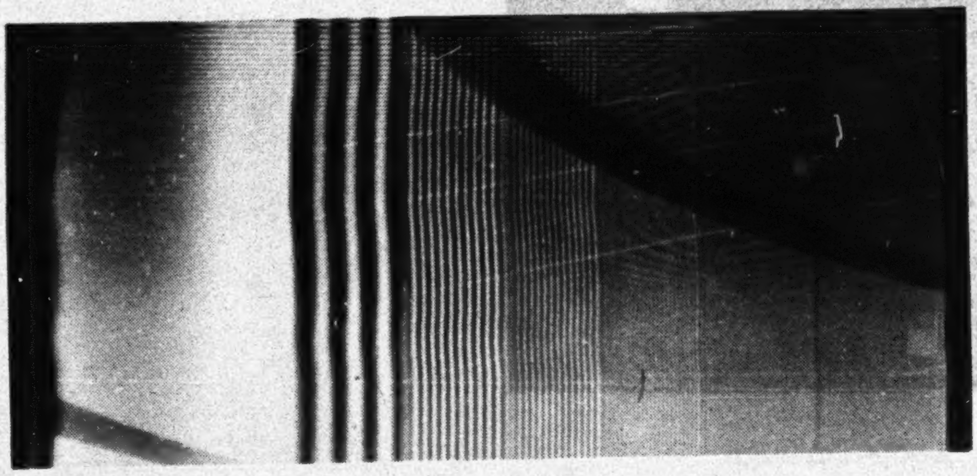


Fig. 11-11 Multiburst "A" Scope Playback

The Sony EV-200 produced a remarkably excellent "A" scope picture on both loop-through and playback. The loop-through electronics was very satisfactory through 3.2 MHz with almost as good a signal on playback. "S" distortion, likewise, was low for an economy helical-scan machine.

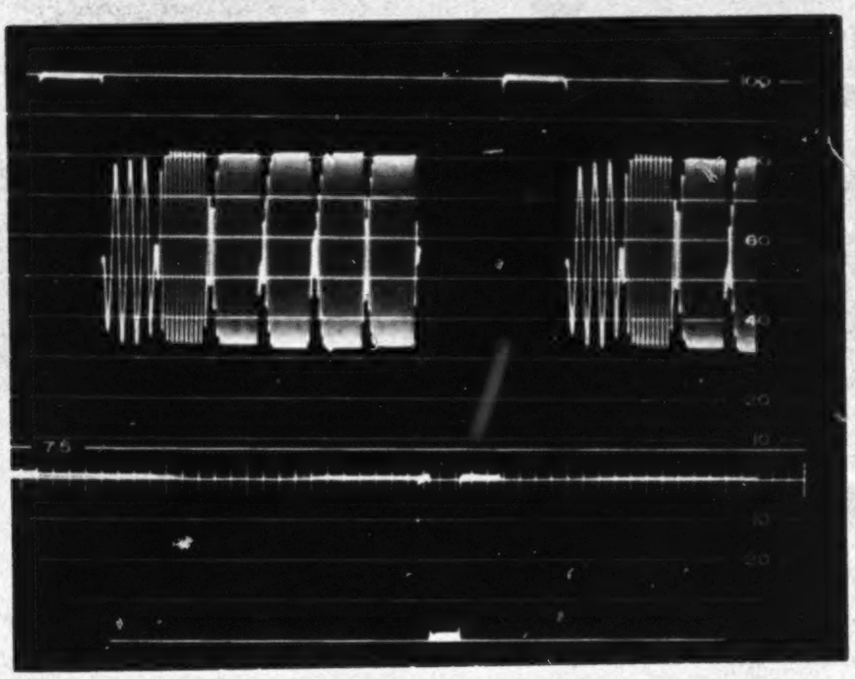
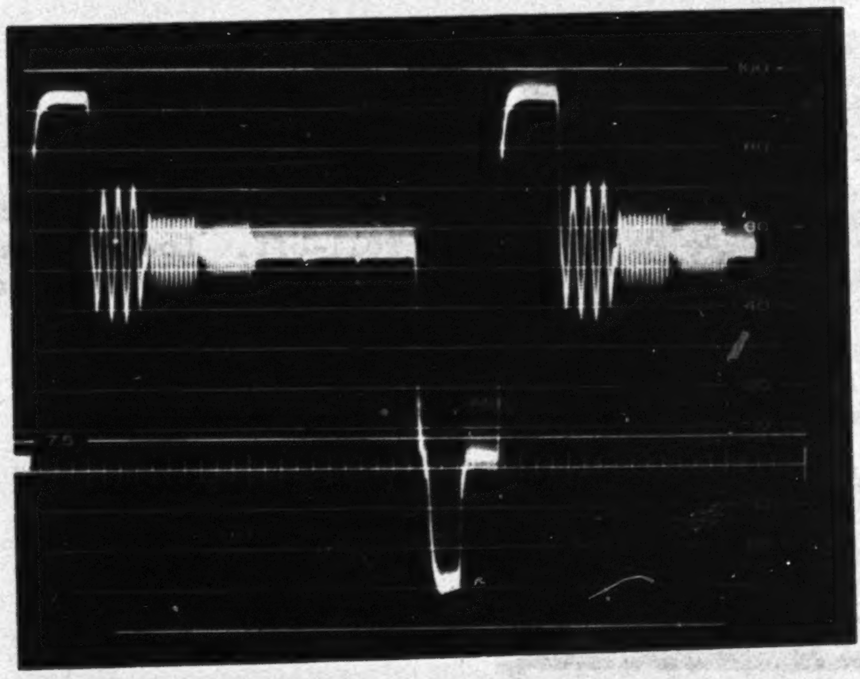
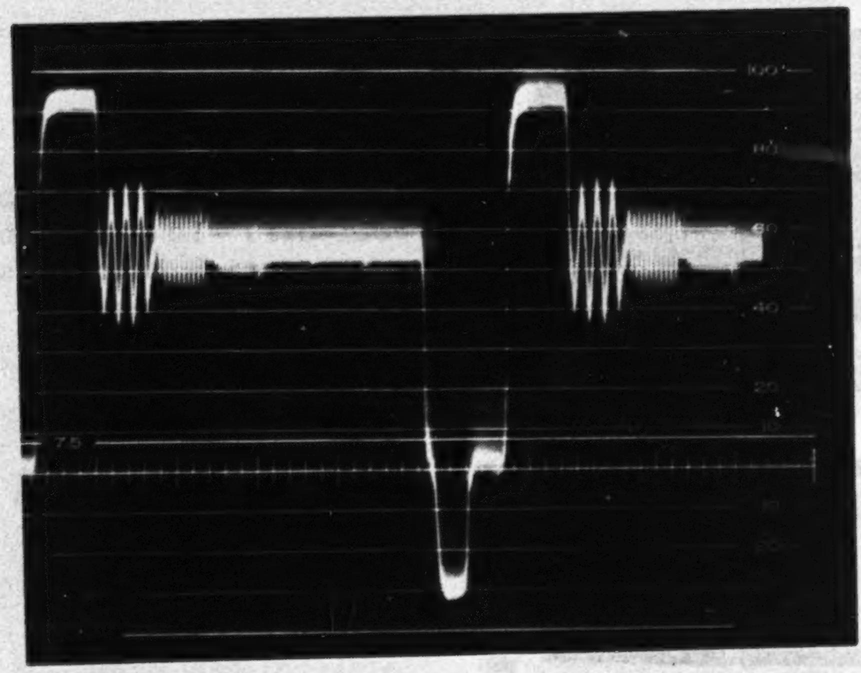


Fig. 12-1 Calibration Multiburst



Flag burst indicates high frequency ringing plus high frequency roll-off. Frequency response 30% down at 0.5 MHz. 50% or more at 1.5 MHz.

Fig. 12-2 Multiburst Loop-Through



Flag burst indicates high frequency ringing and high frequency roll-off. Frequency response 30% down at 0.5 MHz. 50% or more at 1.5 MHz.

Fig. 12-3 Multiburst Playback

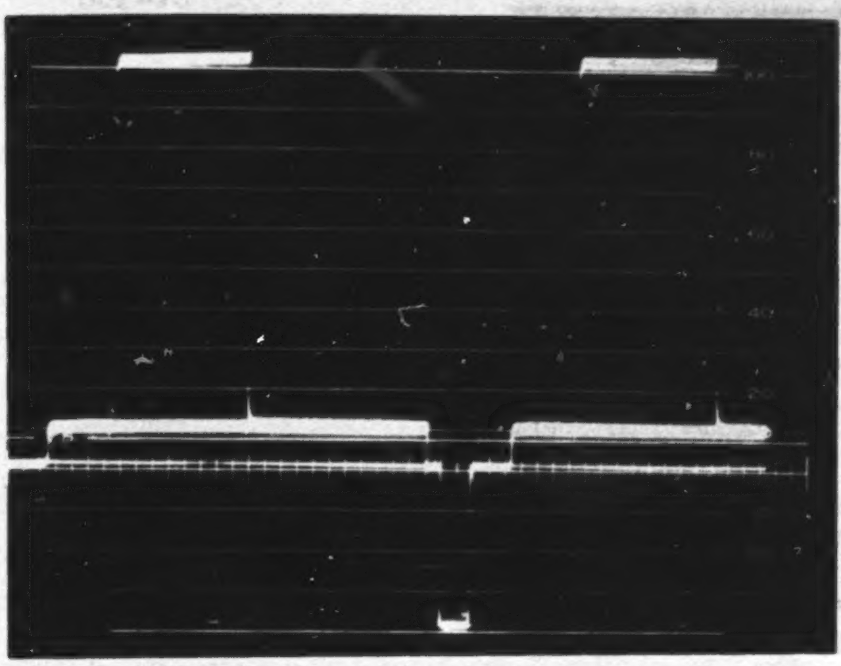
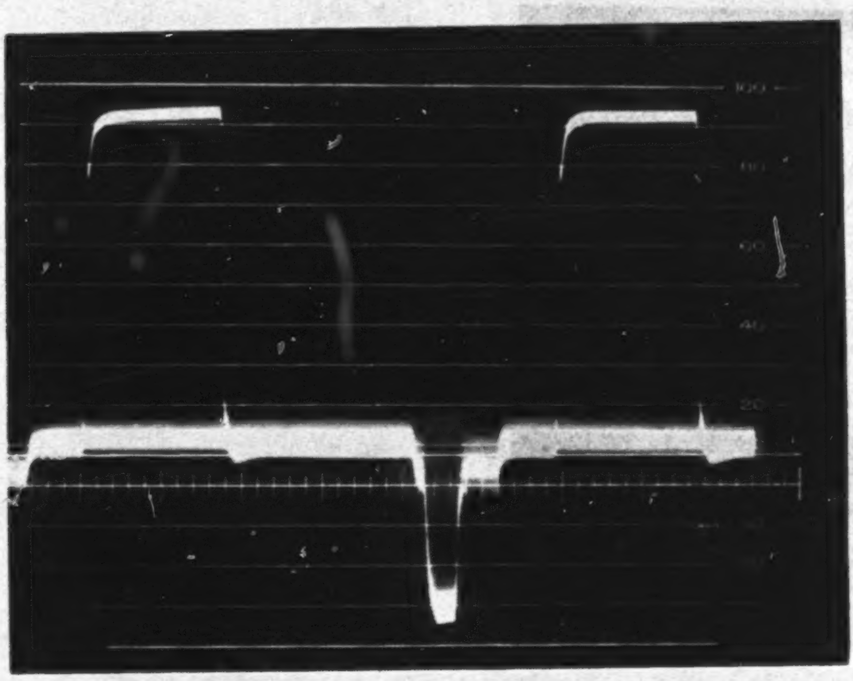
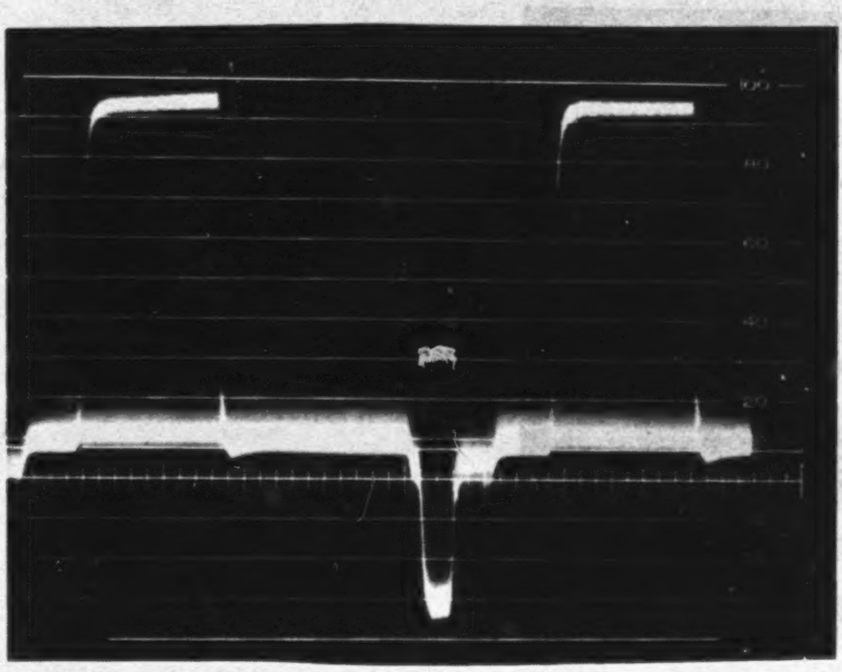


Fig. 12-4 Calibration Window



Indicates high frequency roll-off. Low frequency accentuation. Carrier leak through.

Fig. 12-5 Window Loop-Through



Indicates high frequency roll-off. Low frequency accentuation. Noise and carrier leak through.

Fig. 12-6 Window Playback

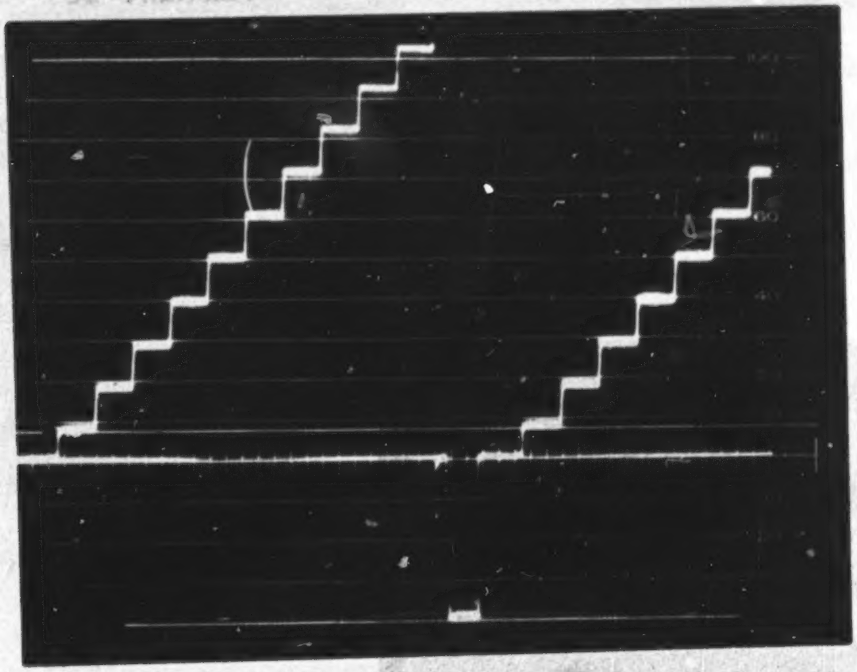


Fig. 12-7 Calibration Stairstep

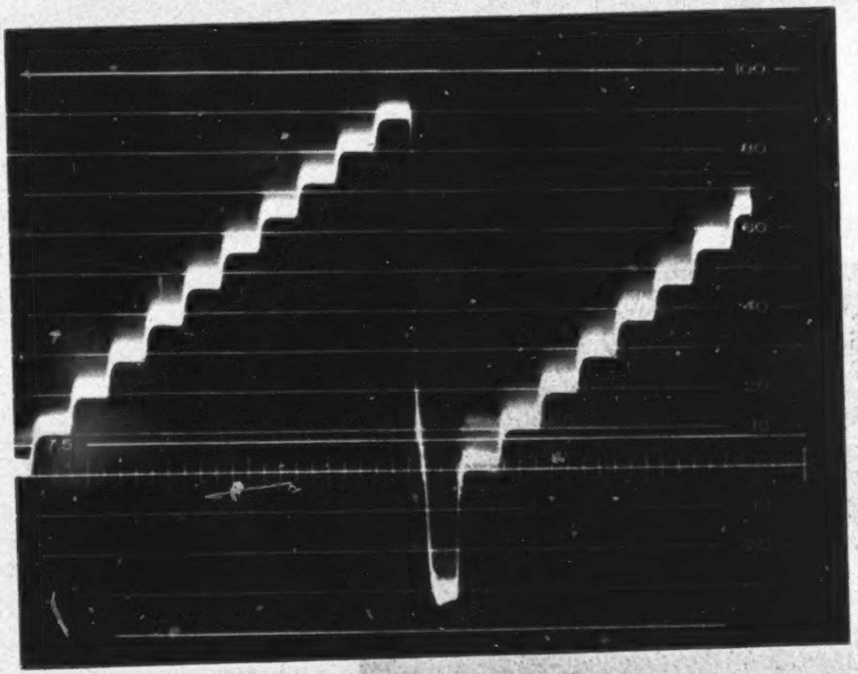


Fig. 12-8 Stairstep Loop-Through

The differential gain distortion is about 2%. Rounding edges of stairstep indicates high frequency roll-off. Blur in picture indicates carrier leak through and/or noise.

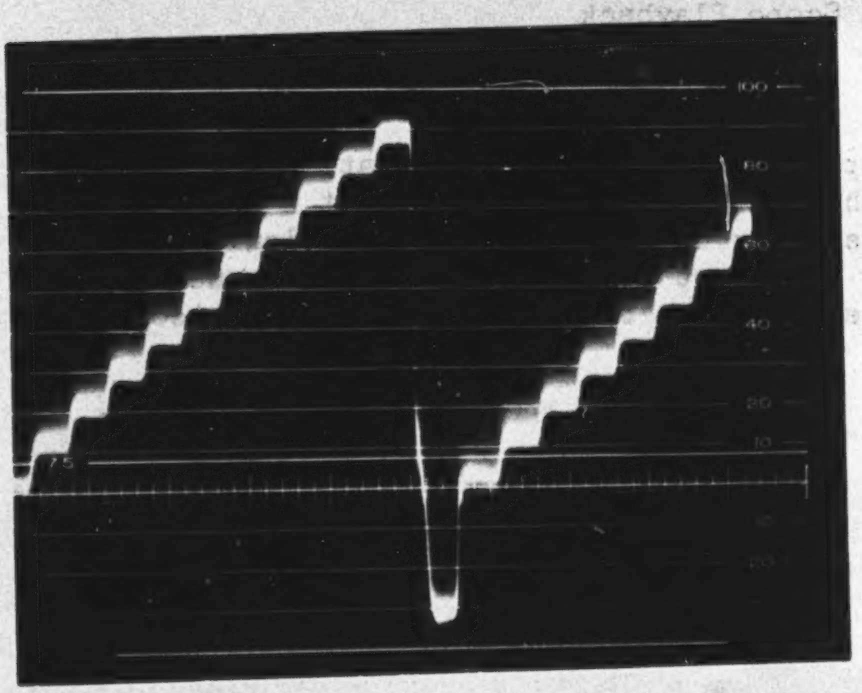


Fig. 12-9 Stairstep Playback

The differential gain distortion is about 2%. Rounding edges of stairstep indicates high frequency roll-off. Blur in picture indicates carrier leak through and/or noise.

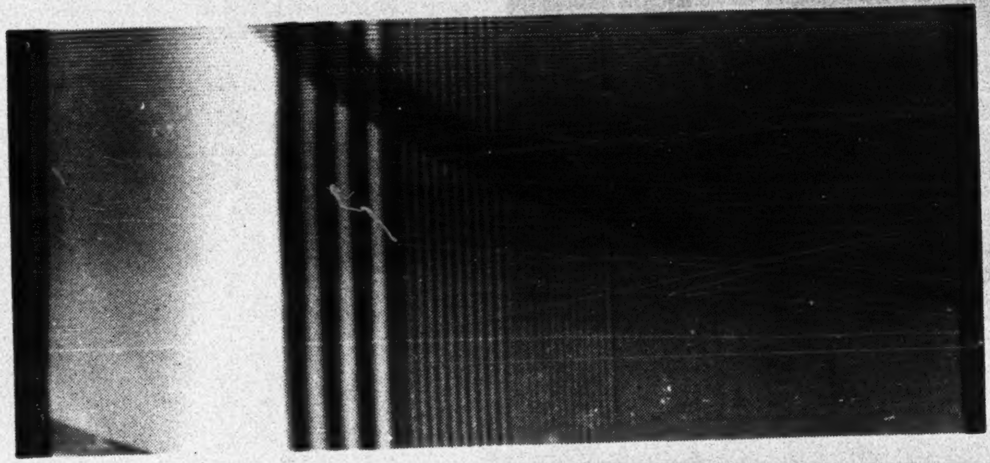


Fig. 12-10 Multiburst "A" Scope Loop-Through

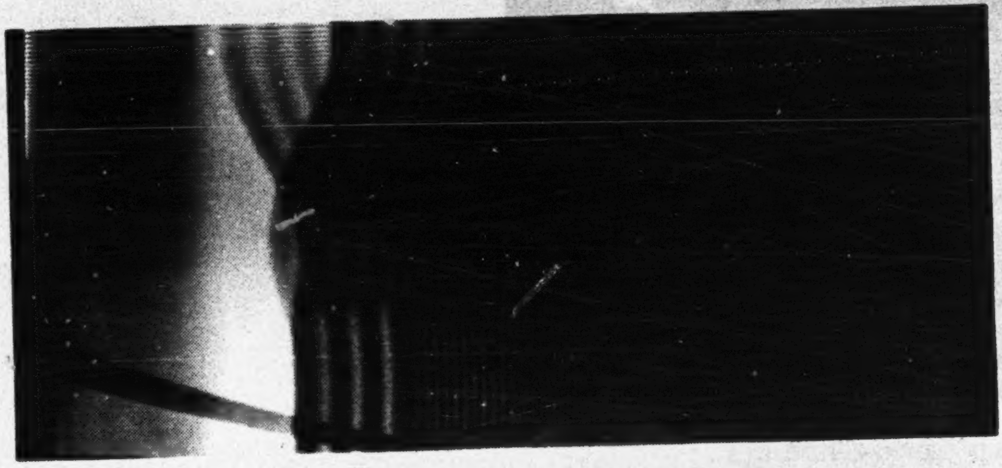


Fig. 12-11 Multiburst "A" Scope Playback

The Sony SV-300 was not represented as being an educational video tape recorder. The loop-through electronics cut off at 2 MHz and was equally low at this frequency on playback. The particular machine submitted for test could not be adjusted with the panel adjustments to prevent breakup of the top portion of the "A" scope picture.

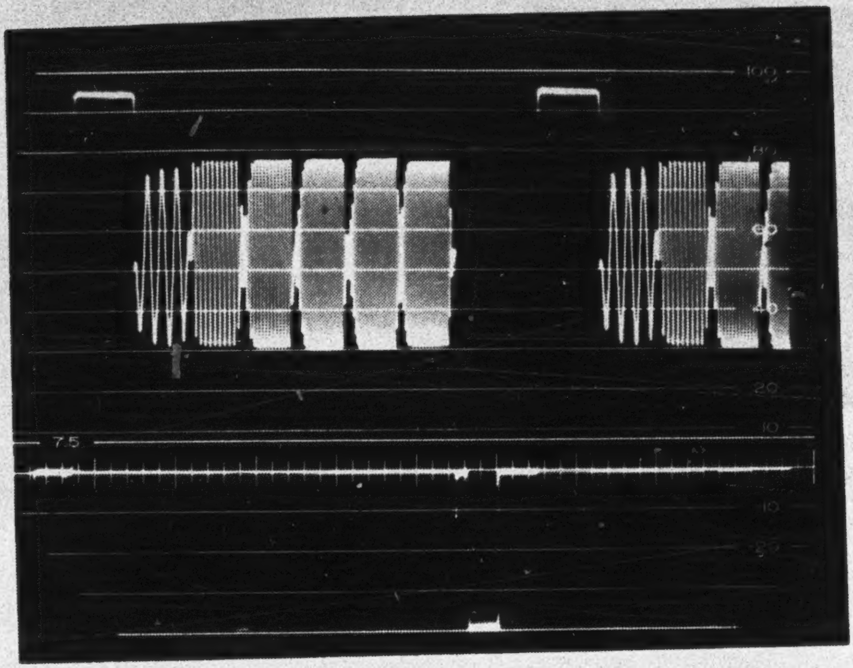


Fig. 13-1 Calibration Multiburst

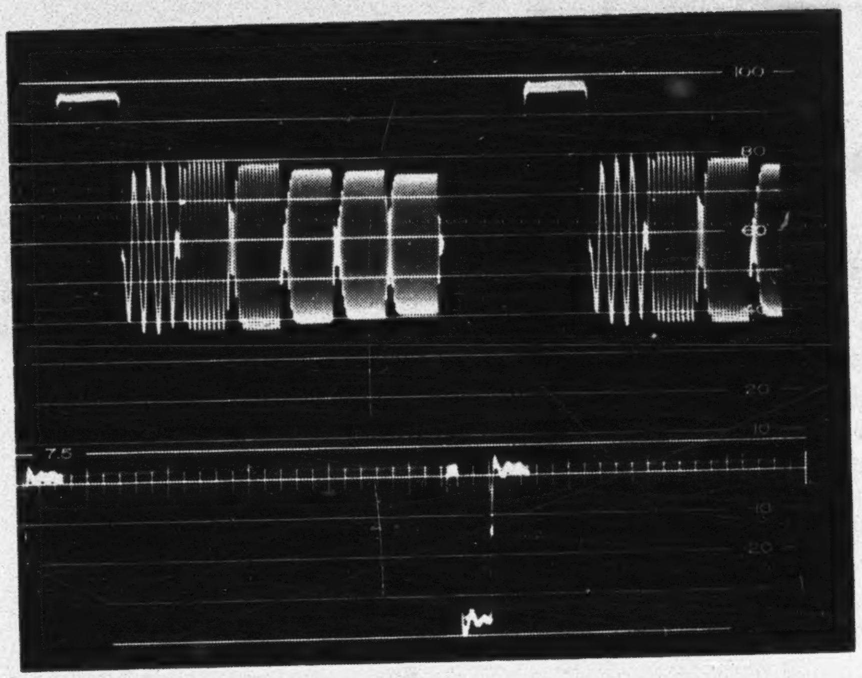


Fig. 13-2 Multiburst Loop-Through

Loop-through signals are through video amplifier and not through any type of modulation and demodulation system. Approximately 15%.

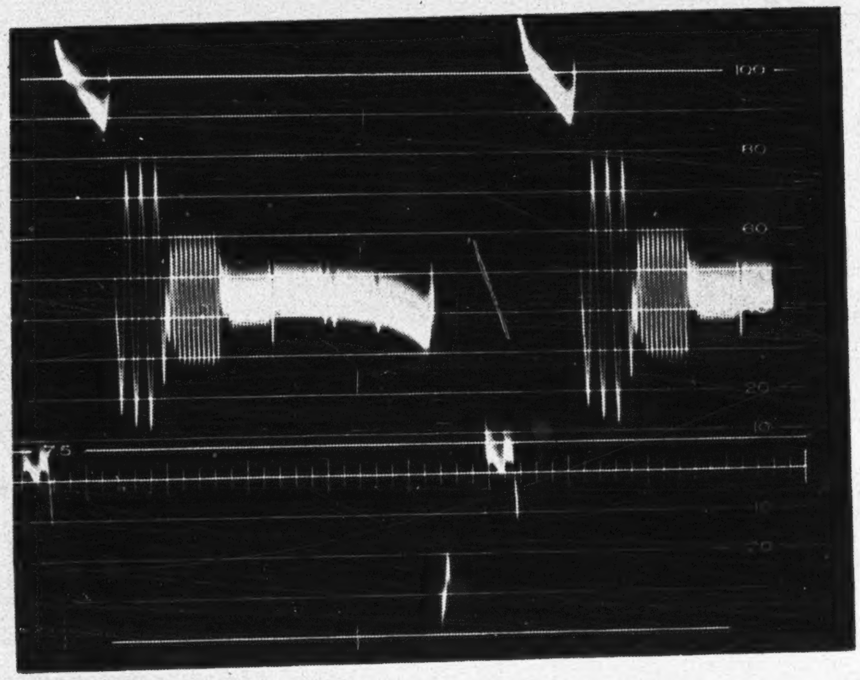


Fig. 13-3 Multiburst Playback

High frequency peaking and ringing indicated. Amplitude of syn pulse extremely long. Frequency response approximately 50% down at 1.5 MHz.

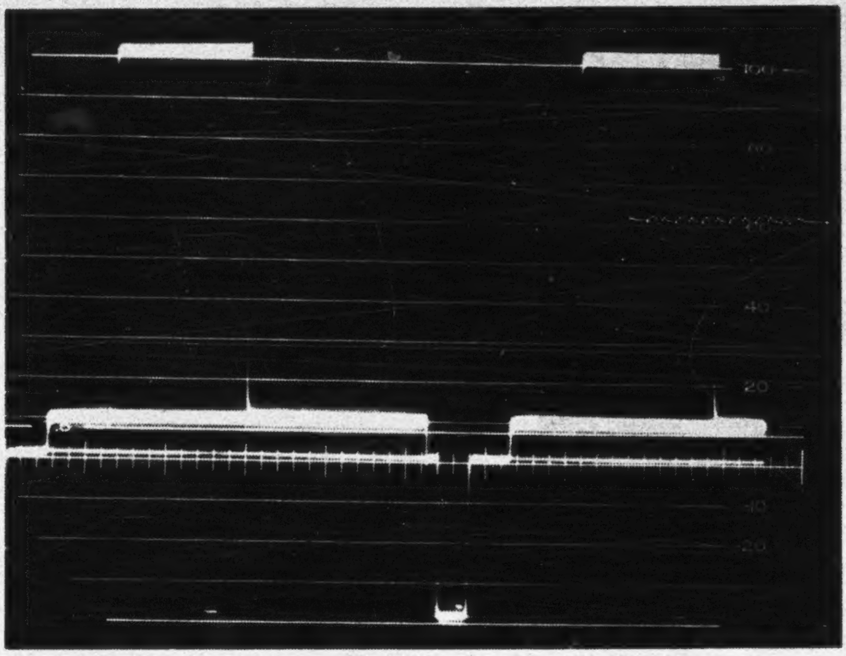
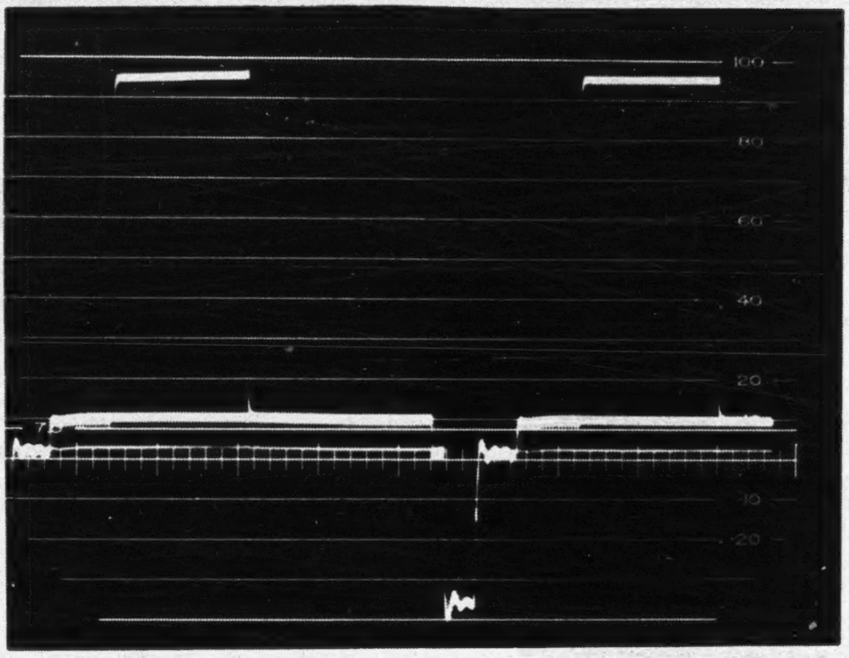
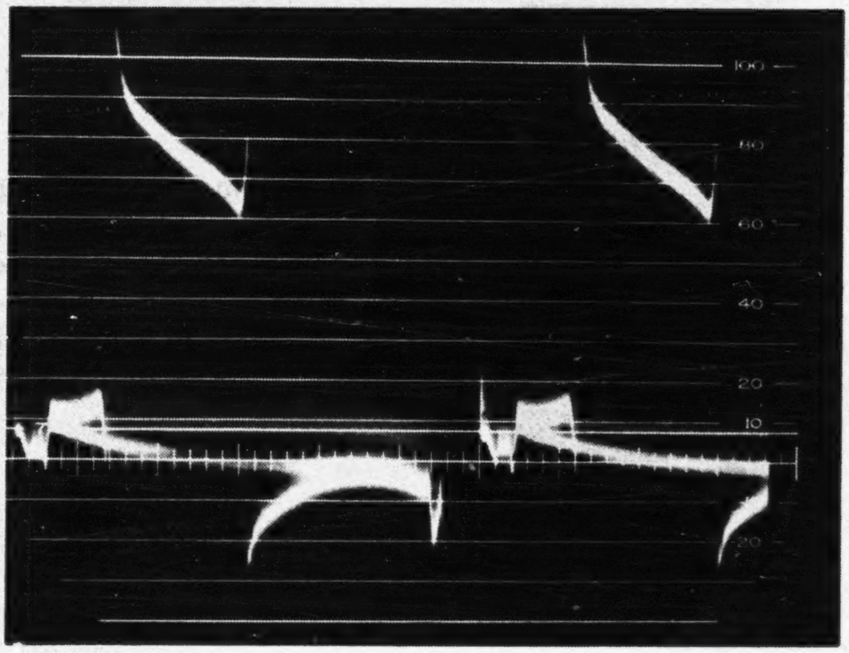


Fig. 13-4 Calibration Window



Loop-through signals are through video amplifier and not through any type of modulation and demodulation system. Approximately 15%.

Fig. 13-5 Window Loop-Through



Window playback extremely high frequency peaking and ringing indicated plus noise.

Fig. 13-6 Window Playback

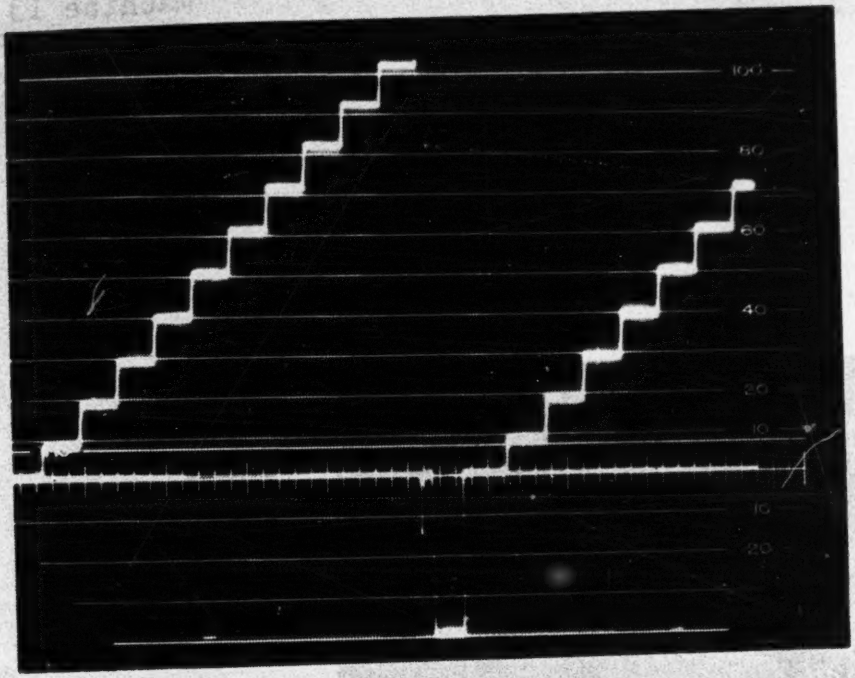


Fig. 13-7 Calibration Stairstep

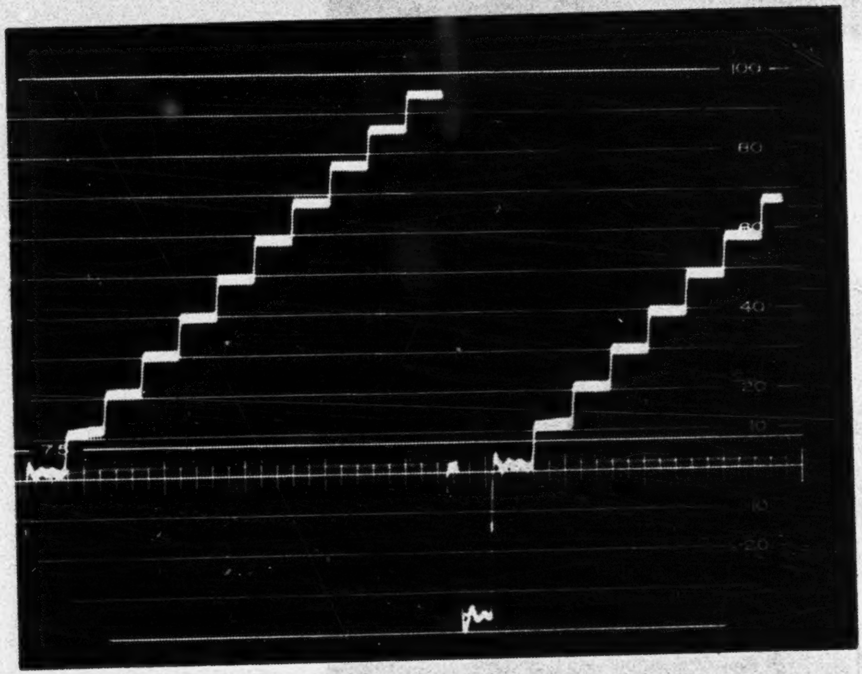


Fig. 13-8 Stairstep Loop-Through

Loop-through signals are through video amplifier and not through any type of modulation and demodulation system. Approximately 15%.

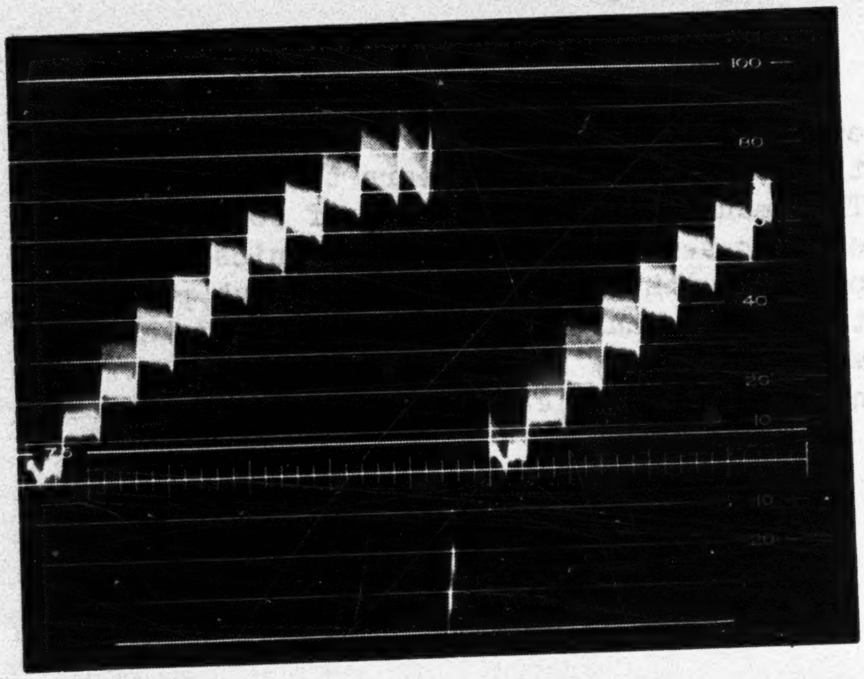


Fig. 13-9 Stairstep Playback

The differential gain is extremely poor. Bad white compensation. High frequency peaking and ringing indicated. Bad noise on output.

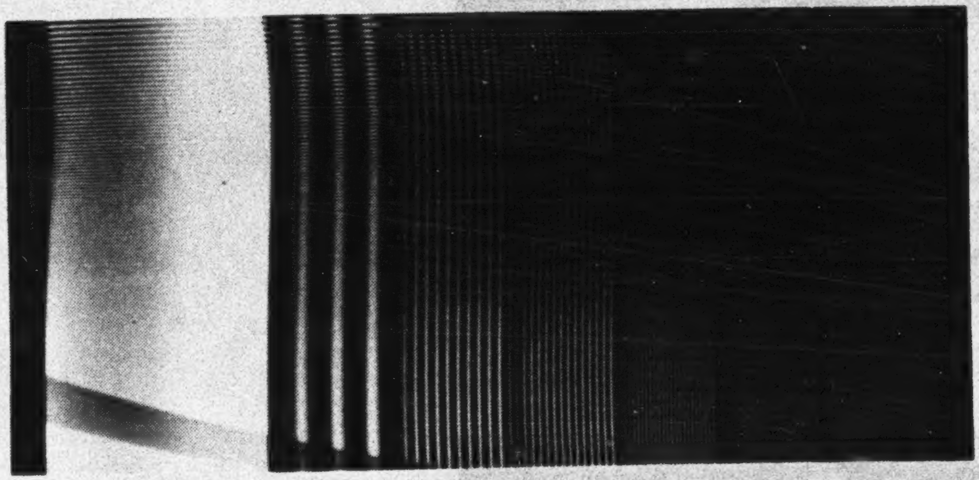


Fig. 13-10 Multiburst "A" Scope Loop-Through

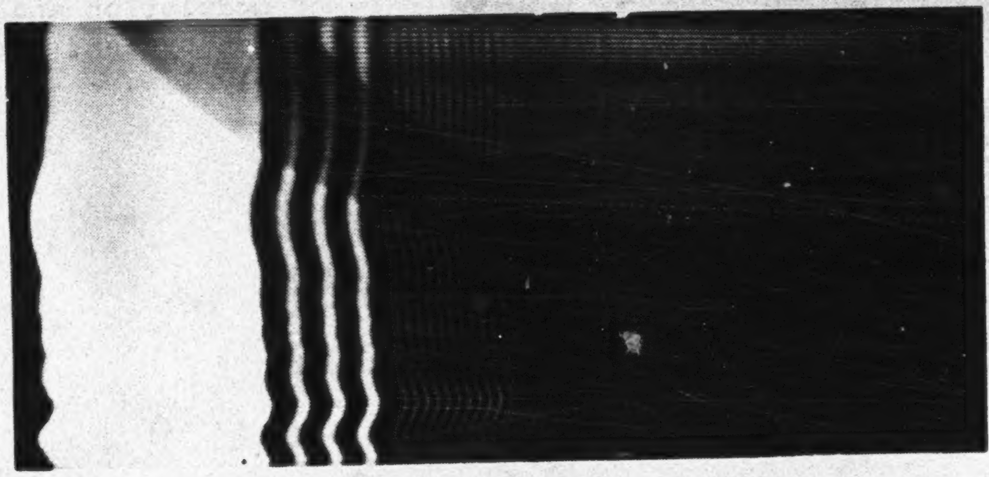


Fig. 13-11 Multiburst "A" Scope Playback

The loop-through "A" scope picture evidently does not involve the modulation and demodulation circuits as it appears to be a direct video amplifier loop. The resulting pictures are, of course, excellent but they do not represent the entire electronics and so the picture cannot be compared with the other loop-through pictures. The playback signals cut off very sharply after 1.5 MHz and the horizontal sync pulses are accordingly reproduced but poorly. The lack of adequate horizontal sync pulses causes the uneven vertical bars.

Chapter VIII

MECHANICAL COMPARISON

A detailed mechanical analysis of each video tape recorder was undertaken. The top and bottom plates of the recorders were removed and the unit was examined from the standpoint of routine maintenance of such items as belts, replacement of heads, accessibility of test points, soldering connections, etc. Chart No. 1 is a comparison of the mechanical construction of the video tape recorders tested based on a rating from "1" to "3", the numeral "1" indicating the most satisfactory condition for each factor considered.

In several of the recorders, it was evident that minor changes had been made after construction; and probably most of the units submitted for test were demonstration models rather than off-the-line models. Consequently, there is no assurance that a different set manufactured by the same company would not have exhibited other characteristics.

MECHANICAL COMPARISON

Chart 1

	Accessibility to Interior of Machine for Maintenance	Ease of Threading	Ease of Control Operation	Ability to Withstand Repeated Rough Handling (Rugged)	Belt Replacement	Over-all Wiring Workmanship	Over-all Soldering	Printed Circuit Quality	General Mechanical Condition
Ampex VR-660B	3	1	1	3	2	3	3	3	3
Ampex VR-1100	1	1	1	2	1	1	2	1	1
Ampex VR-6000	1	3	3	3	3	2	2	2	3
Ampex VR-7000	2	3	3	2	2	2	2	3	2
Concord VTR-600	3	2	1	2	2	2	3	3	3
Machtronics MVR-65	1	1	1	1	3	1	1	1	1
Precision PI-3V	3	1	1	2	2	1	1	2	2
Precision PI-4V	3	1	1	3	3	2	2	2	3
RCA VTR-5	1	2	1	2	2	3	3	3	3
Sony PV-120U	1	2	1	1	1	1	2	1	2
Sony EV-200	1	2	3	2	1	1	2	2	2
Sony SV-300	1	2	1	2	2	2	3	3	2
3M Wollensak VTR-150	1	1	1	2	1	2	2	1	3

CHAPTER IX

COMPARATIVE VITAL STATISTICS AS SUPPLIED BY MANUFACTURERS

NAME OF MACHINE	PRICE	HEIGHT INCHES	WIDTH INCHES	LENGTH INCHES	WEIGHT POUNDS	VIDEO IN v. p-p	VIDEO OUT v. p-p	TAPE WIDTH INCHES	TAPE SPEED IPS	REEL SIZE INCHES
Ampex VR-660B	$ 8,000	14-5/8	29-7/8	17-3/8	100	.5 - 2.0	.5 - 2.0	2	3.7	12-1/2
Ampex VR-1100	27,900	74	42-1/4	27	800	1.0	1.0	2	15 or 7-1/2	14
Ampex VR-6000	1,450	10	25	14	65	1.0	1.0	1	9.6	9-3/4
Ampex VR-7000	3,150	15	29	18	80	1.0	1.0	1	9.6	9-3/4
Concord VTR-600	1,150	10-1/2	16-1/2	17	53	1.0	1.0	1/2	12	7
Machtronics MVR-65	11,350	10-3/8	24-7/16	13-7/32	84	0.5V-1.4	0.5-1.4	1	7.5	10-1/2
Precision PI-3V	7,800	10-3/8	24-7/16	13-7/32	75	0.5-1.4	0.5-2.0	1	7.5	10.5
Precision PI-4V	11,500	10-3/8	24-7/16	13-7/32	85	1.4	1.4	1	8.46	10-1/2
RCA VTR-5	18,905	37	33	27	475	0.8-1.2	1.0	2	7-1/2 & 15	12-1/2
Sony PV-120U	8,950	25	17-1/2	16-3/4	150	0.5-1.5	0.5-2.0	2.0	4.25	7
Sony EV-200	3,550	17-7/8	11-1/8	26	88	0.5-2.0	0.5-2.0	1.0	7.8	8
Sony SV-300	1,250	11	18	15	45	-1 to 2	1 to 2	1/2	7.5	7
3M Wollensak VTR-150	1,495	9	14	19-1/2	47	1	1	1/2	7-1/2	7

NAME OF MACHINE	NO. OF HEADS	HEAD WIDTH MILS	HEAD GAP u INCH	HEAD VELOCITY IPS	PROTRUSION MILS	SLANT ANGLE DEGREES	HEAD SPEED RPM
Ampex VR-660B	2	7-1/2	60	650	5	9	1800
Ampex VR-1100	4	10 - 15 ips 5 - 7-1/2		1500	3	90	14,400
Ampex VR-6000	1	6	95	1000		3	3600
Ampex VR-7000	1	6	55	1000		3	3600
Concord VTR-600	3	12	0.039	484	20	3.16	1800
Machtronics MVR-65	2	8	0.5 mils	645	5.0	7	1800
Precision PI-3V	2	8	0.04 mils	620	8	4-1/2	1800
Precision PI-4V	2	8	0.04	620	8	4-1/2	1800
RCA VTR-5	4	5 & 10	.090	1561	3.0	3.0	14,400
Sony PV-120U	2	7	40	740	8	17°17'17"	3600
Sony EV-200	2	6	NA	590	6		1800
Sony SV-300	2	NA	2	425	NA	NA	1800
3M Wollensak VTR-150		15		180	1.7	9°52'	3600

NAME OF MACHINE	HEAD LIFE HOURS	BANDWIDTH ELECTRONICS	BANDWITTH PLAYBACK	SIGNAL-TO-NOISE	RESOLUTION IN LINES	FCC TIMEBASE	TRANSISTORS	TEMPERATURE 5% DETERIORATION
Ampex VR-660B	250	3.0 MHz	3/0 MHz	40 db	270	Yes	All	
Ampex VR-1100	100	4.0 MHz	4.0 MHz	40 db	350	Yes	All	
Ampex VR-6000	500	3.0 MHz	3.0 MHz	40 db	250	No	All	
Ampex VR-7000	500	3.5 MHz	3.5 MHz	42 db	310	No	All	
Concord VTR-600	750	3.3 MHz	2.6 MHz	40 db	250	Yes	62	1 5°C, h 50°C
Machtronics MVR-65	250	3.5 MHz	3.5 MHz	42 db	320	Yes	193	1 0°C, h 45°C
Precision PI-3V	250	3.5 MHz	3.5 MHz	30 db	300	Yes	54	1 40°F, h 120°F
Precision PI-4V	250	3.5 MHz	3.5 MHz	30 db	300	Yes	84	1 40°F, h 120°F
RCA VTR-5		25Hz- 4.5MHz	25Hz- 4.5MHz	40 db	400	Yes		1 0°C, h 45°C
Sony PV-120U	500	3.3 MHz	3.3 MHz	42 db	330	Yes	175	1 10°C, h 40°C
Sony EV-200	500	3 MHz	3 MHz	40+ db	320		100	1 10°C, h 40°C
Sony SV-300	500	NA	2.5 MHz	40 db	180 to 200	No	51	
3M Wollensak VTR-150		2 MHz	2 MHz	35 db	160	No	48	

NAME OF MACHINE	SLOW SPEED POSSIBLE	STOP FRAME POSSIBLE	RACK MOUNT	FOOTAGE COUNTER	INTERCHANGE OF TAPE	AUDIO TRACKS	AUDIO DISTORTION	REMOTE CONTROL
Ampex VR-660B	Yes	Yes	No	No	Yes	2	1.0%	Yes
Ampex VR-1100	No	No	No	Yes	Yes	2	1%	Yes
Ampex VR-6000	No	Yes	No	Yes		1	1.0%	No
Ampex VR-7000	No	Yes	No	Yes	Yes	1	1.0%	Yes
Concord VTR-600	No	Yes	No	Yes	Yes	1	amplifier is in monitor	Yes
Machtronics MVR-65	Yes	Yes	No	Yes	Yes	2	1%	Yes
Precision PI-3V	No	Yes	No	Yes	Yes	1	3%	Yes
Precision PI-4V	Yes	Yes	No	Yes	Yes	2	3%	Yes
RCA VTR-5	No	No	No	No	Yes	1 Std. 1 Opt.	3%	Yes
Sony PV-120U	Yes	Yes	Yes	Yes	Yes	2	Less than 6%	Yes
Sony EV-200	Yes	Yes	Yes	Yes	Yes	2	Less than 3%	
Sony SV-300	No	Yes	No	Yes	Yes	1	NA	No
3M Wollensak VTR-150	No	No	No	No	Yes	1	3%	No

NAME OF MACHINE	MODULATION SYSTEM	DEMODULATION SYSTEM	LOCAL ADDRESS
Ampex VR-660B	Hetrodyne Modulator	Pulse Counter Detector & Low Pass Filter	Ampex Corporation 2220 Bay Road, Redwood City, California 94063
Ampex VR-1100	Multivibrator	Pulse Counter Detector & Low Pass Filter	Ampex Corporation 2220 Bay Road, Redwood City, California 94063
Ampex VR-6000	Multivibrator	Pulse Counter Detector & Low Pass Filter	Ampex Corporation 2220 Bay Road, Redwood City, California 94063
Ampex VR-7000	Multivibrator	Pulse Counter Detector & Low Pass Filter	Ampex Corporation 2220 Bay Road, Redwood City, California 94063
Concord VTR-600	Double Side Band FM	Double Filter	Concord Electronics Corporation 1935 Armacost Avenue, Los Angeles, California 90025
Machtronics MVR-65	FM	Pulse Counter Demodulator	MVR Corporation 470 San Antonio Road, Palo Alto, California 94306
Precision PI-3V	Frequency Modulation	Frequency Demodulator	Precision Instrument Company 3170 Porter Drive, Palo Alto, California 94304
Precision PI-4V	Frequency Modulation	Frequency Demodulator	Precision Instrument Company 3170 Porter Drive, Palo Alto, California 94304
RCA VTR-5	Heterodyne Modulator	Pulse Counter Demodulator	Radio Corporation of America 420 Taylor Street, San Francisco, California
Sony PV-120U	FM Modulation	FM Demodulator	Sony Corporation of America 926 Industrial Avenue, Palo Alto, California
Sony EV-200	FM Modulation	FM Demodulator	Sony Corporation of America 926 Industrial Avenue, Palo Alto, California
Sony SV-300	FM with Double Side-band Recording	Limiters with Discriminator Detector	Sony Corporation of America 926 Industrial Avenue, Palo Alto, California
3M Wollensak VTR-150	None	None	3 M Company 320 Shaw Road, South San Francisco, California

Chapter X

CONCLUSIONS

From the data furnished under comparison of technical vital statistics, it is obvious there is absolutely no compatibility between different manufacturers of equipment with one exception: RCA and the Ampex quadraplex machines. The remainder of the machines almost without exception differ in such categories as tape width, head velocity, record head width, type of modulation, FM carrier frequency, slant angle, diameter of recording head, and virtually every significant electronic characteristic.

A further conclusion can be drawn that the problem will probably increase rather than decrease in the near future. During the time that this project was in the planning and execution stages, the Dage DV-300 was withdrawn from the project because it was to be replaced with a new model. Westel Company demonstrated a portable machine at the NAB conference in Chicago, but was unable to furnish a production model prior to the conclusion of this project. The following additional companies are either in process of planning machines or have a machine that was not available for examination:

Ampex Corporation (Models Nos. 1200 and 2000)
Fairchild Industrial Products
General Electric Company
Ikegami Electronics Industries, Inc.
International Video Corporation
Matsushita (Panasonic) Company
North American Philips Company, Inc. (Norelco El-3401A/54)
Par, Ltd.
Sony Corporation of America (Model No. TCV-2010)
Wesgrove Electronics, Limited
Winston Research Corporation

Since video tape machines are added to the presently available list, others are delayed, and still others are improved, it would seem realistic for the State of California to have a continuing testing program to examine machines as they are made available to school systems. The results could be an addenda to this report, and this might enable the administrators to keep up to date on the state of the art.

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LIGHTING

The typical classroom has a varying light intensity from approximately 10 foot-candles to 50 foot-candles. This light intensity is minimum for Image Orthicon cameras. The light intensity in the typical classroom is wholly inadequate for a Vidicon camera. While the present-day Vidicon camera can produce a picture at this light level, at least two factors combine to produce a less than satisfactory telecast.

1. As the light level decreases, the electronic circuitry in the Vidicon camera can be adjusted to produce an electron signal which compensates for the decrease in light level. This electronic manipulation, however, decreases the signal-to-noise ratio and has the effect of increasing the background random light pulses. This effect is referred to as "snow."
2. The light level reaching the camera tube itself may be increased by increasing the camera aperture. Increasing the camera aperture decreases the depth of focus. The depth of focus is measured by the number of feet that the object may move toward or away from the camera before the picture blurs. Thus, with a low light level, the classroom teacher must remain within a foot or two of the initial distance from the lens of the camera in order that the picture stay in focus. It is obvious that this is a severe handicap to the teacher and perhaps an impossible situation.

It may be entirely impracticable to bring in a sufficient amount of light into a regular classroom to permit televising the teacher in this situation. Approximately 200 foot-candles are required for satisfactory results with a Vidicaon camera. This would put a uniform light intensity over the floor of a normal classroom, and illuminate the chalkboard, the teacher's desk, and possibly a map on the side of the wall. This may require as much as 15,000 watts of light. This light intensity in turn generates enough heat that the room temperature rises unduly and, in practical cases, requires air-conditioning and refrigeration to keep the room comfortable.

The Image Orthicon camera, on the other hand, will operate with some degree of success with from 50 to 100 foot-candles of light. The Image Orthicon camera, however, is both an expensive instrument and requires special adjustments and handling for each telecast to produce satisfactory results. A technical crew of two persons is a minimum crew to safeguard and to properly use the capability of the Image Orthicon camera.

VISUAL AIDS

Programs that have proven to be effective for teaching by television make massive use of visual aids. A television lesson that is written on a blackboard in a dimly lit classroom will reproduce by television more poorly than the same lesson produced live by the instructor.

Visual aids properly prepared and skillfully used are most effective. The visual aids that some teachers may find difficult to prepare entirely by themselves are:

1. Flip cards and other printed material. This requires access to a printing press, paste-on type, photographed menu bulletins, and hand-lettered material. Graphic material prepared on an ordinary typewriter is so inferior when compared with what the child sees in his favorite television show as to be ineffective and probably negative in effect.
2. The use of animated devices. Most teachers are not familiar with the various types of machine-operated gadgets, objects, and figures that make a first-rate television program a success. The Walt Disney approach to learning may be effective, but it requires the imagination, skill, and ability found only in a limited number of people. The absence of skillful visual aids turns an otherwise good television lesson into an ordinary look-and-see program.
3. Objects and models. A good television lesson may require an extensive use of models, objects, and other pieces of equipment to illustrate the point. Most individual teachers have neither the time to look for nor the knowledge as to where this kind of equipment is available. One major difference between a television lesson produced in a major studio and the ordinary classroom is the access the studio has to countless sources of models and devices.

4. **Motion Picture Clips.** A motion picture clip is a small section of motion picture abstracted from a commercial film or photographed by the studio. A school system rarely has the equipment and the trained technicians capable of producing acceptable motion picture material. Such motion pictures not only add to the program but they very often depict situations that could not be produced otherwise. For example, it is usually impossible for the television camera to view a flag waving in the breeze directly. This requires that the few seconds of the scene be either photographed directly by a motion picture camera or that this portion be cut from a commerically made film.

If commercial film is used for film clips, great care must be taken that all commercial rights have been respected and that the institution has complied with the latest copyright rules. One of the present pertinent rules is that the district may use (in a purely closed-circuit situation) material taken from a motion picture without paying a royalty provided that this material is not used after six months. This means that the complete production must be redone every six months or the school must carefully and meticuously check copyright laws and obtain releases.

For the above reasons, it becomes virtually impossible for a small operation to include motion picture clips in a television production.

In addition to the matter of procuring the motion picture clip, an entire new dimension must be added to the technical equipment in order to make it possible to incorporate tha motion picture clips.

It suddenly becomes necessary to add a motion picture projector and the related camera, a switching system, and an operator to incorporate the film clip at the proper place. Few if any motion picture clips will be used in a small school television system.

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